Research organizations under scrutiny
New indicators and analytical results
20th International Conference on Science and Technology Indicators

Lugano, 2nd – 4th September 2015

Book of abstracts
Conference sponsors

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Welcome to STI 2015

I am happy to welcome you to the 20th International Conference on Science and Technology Indicators (STI2015) organized by the Institute of Management and by the Institute of Interdisciplinary Data Science of the Università della Svizzera italiana under the auspices of the European Network of Indicator Designers association (ENID). In the STI series, this year’s conference comes with a specific focus on characterizing research organizations, including higher education institutions, public research organizations, funding agencies and firms.

Since a long time, organizational scholars recognized that organizations are one of the main building blocks of modern society. In the science and technology system, organizations fulfil central functions, like organizing careers of individual scientists and evaluating their performance, defining and implementing strategies concerning research domains and priorities, managing and distributing the largest part of research funding to individual groups and individuals. Hence, on the one hand, the need of better understanding their functioning and, on the other hand, to dispose of reliable indicators to characterize their behavior and their positioning in the overall STI system.

In this context, indicators at the organizational level raise relevant technical, but also conceptual and methodological issues. At the methodological and technical level, some key issues are how to move from aggregated data mostly referring to individuals, like numbers of publications or citations, to meaningful measures at the organizational level, considering that original distributions are mostly highly skewed; a proper identification of organization and definition of their boundaries is also problematic. At the theoretical level, the relationship between measures and organizational behavior needs to be carefully conceptualized. Organizations are not purely passive objects of measures, but tend be highly strategic in using and manipulating indicators, especially when confronted with ambiguity; indicators are socially constructed by organizations themselves and, therefore, are likely to embed also the outcome of power and interests struggles between actors, within and outside the organization. Insights from the sociology of measure could be particularly helpful to develop more in-depth this link.
To address these central issues for our community, this year’s STI conference proposes a program composed by different complementary elements. Keynote speeches by distinguished scholars in organizational studies address upfront the general and theoretical questions about indicators in and for organizations: paper presentation sessions propose advances in STI indicators in different fields and their relevance for organizational strategies and behavior; four panel discussions focus in-depth on relevant topics (methods; researcher’s careers; standardization and integration; research responsible innovation). The poster session will also provide an opening towards new emerging research in the field. Finally, two core events for the whole conference are the panel on the dynamics of standards in Science and Technology Indicators – both from a measure and from an organizational perspective – and the final session on how to develop a sustainable data infrastructure for our field of studies.

I wish to thank all people who made possible this conference: the members of the conference program committee and those of the scientific committee, who attended the task of building the program and to select scientific contributions; the keynotes for their availability to contribute; the Università della Svizzera italiana for support and for providing the needed infrastructure; the conference sponsors for their generous support. And finally, members of the organizing committee for taking care of indispensable practical and logistics tasks.

I wish you an excellent conference.

Benedetto Lepori, Center for Organizational Research, Università della Svizzera italiana.

Conference Chair
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Conference organization

Program chair
Benedetto Lepori, Università della Svizzera italiana, Lugano.

Program board
The program board is responsible for the scientific supervision of the conference, for taking final decisions on submissions and for compiling the program. It consists of 5 experts which, together, cover the full spectrum of the conference.

Benedetto Lepori, Università della Svizzera italiana, Lugano.
Patrick Llerena, BETA, University of Strasbourg.
Thed van Leeuwen, CWTS, University of Leiden.
Jordi Molas Gallart, INGENIO, CSIC -University of Valencia.
Magnus Gulbrandsen, University of Oslo.

Responsible for RISIS events
Sybille Hinze, IFQ, Berlin.

Responsible for the poster session
Emanuela Reale, CNR IRCRES, Rome

Local organizers
Benedetto Lepori, Università della Svizzera italiana, Lugano.
Raluca Hodoroaba, Università della Svizzera italiana, Lugano.
Scientific committee

The scientific committee consists of members of the STI community involved in the reviewing process of the submitted papers.

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## Conference programme

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### Day 1. Wednesday 2\textsuperscript{nd} of September

- **9.00** Registration desk, Auditorium foyer
- **9.30** Welcome coffee, Auditorium foyer
- **10.00** Conference opening, Auditorium
  - Welcome address: Piero Martinoli, President of the Università della Svizzera italiana.
  - Welcome address: Ton van Raan, President of the European Network of European Designers association.
  - Introduction: Benedetto Lepori, Università della Svizzera italiana, Conference chair.
  - Presentation of the poster session: Emanuela Reale, CNR, Rome, Chair of the poster session.
- **10.20** Opening speech, Auditorium. Universities between bureaucracy and market pressures: selected reflections from an organization theory perspective.
  - Filippo Carlo Wezel, Institute for Management, Università della Svizzera italiana.
- **11.00 – 12.30** Paper presentations
  - Evaluation and its outcomes
  - Chair: Jordi Molas Gallart, INGENIO, Valencia
- **11.00 – 12.30** Paper presentations
  - Technology transfer and cooperation between academia and industry
  - Chair: Matthias Weber, Austrian Institute of Technology
- **12.15** Lunch, Covered space at the USI main building back entrance
- **13.45 – 15.15** Panel session
  - Research Responsible Innovation (RRI).
  - Chair: Emanuela Reale, CNR-IRCRES, Rome.
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<td>Barry Bozeman, Arizona State University</td>
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<td>Paper presentations Academic careers</td>
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<td>10.45 – 12.30 Paper presentations Dynamics of research fields</td>
<td>Gunnar Sivertsen, NIFU, Oslo</td>
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<td>Joseph Lampel, Manchester Business School, University of Manchester</td>
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<td>Chair: Peter van den Besselaar, VU University, Amsterdam</td>
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<td>12.30</td>
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<td>Closing session Establishing an European data infrastructure for research and innovation policy studies, Auditorium</td>
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<td>Announcement of STI 2016 (Jordi Molas- Gallart).</td>
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<td>15.45</td>
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Opening speech.

Universities between bureaucracy and market pressures: selected reflections from an organization theory perspective

Filippo Carlo Wezel, Institute of Management, Università della Svizzera italiana.

Wednesday, 2nd of September 2015, 10.20 - 11.00, Auditorium

The world of Universities is undergoing significant changes. On the one hand, Universities are requested to exhibit accountability to justify public funding under increased budgetary constraints. On the other, the competition for funding and for mobile students grants Universities access to unprecedented incentives to productivity. The simultaneous push towards increased professionalism and economic rewards renders Universities an appealing context in which exploring the effects of hybrid forms of organizing on individual productivity and turnover. The discussion is generalized to alternative market settings in which other organizations face a similar trade-off.
Keynote speeches


Barry Bozeman, Arizona Centennial Professor of Technology Policy and Public Management, Arizona State University

Wednesday, 2nd of September 2015, 17.00 - 18.15, Auditorium

Discussants: Patrick Llerena, BETA, University of Strasbourg and Magnus Gulbrandsen, University of Oslo.

Motivation: Barry Bozeman is one the very few scholars who gave important contribution both to organizational studies, particularly around the notion of “publicness” and, in general, with the theory of public administration, and S&T studies, dealing especially with evaluation and human resources assessment. Therefore, it is the best keynote for addressing the specific topic of the conference.

Keynote 2. Standards as Socio-economic constructions

David Seidl, Chair of Organization and Management, University of Zurich

Thursday 3rd of September 2015, 14.00 - 15.45, Auditorium

The keynote is followed by a panel on Standards in research evaluation and the Leiden manifesto.

David Seidl worked extensively on the processes leading to the establishment of standards and their development within organizations. On this topic, he edited a special issue of Organization Studies together with Nils Brunsson and Andreas Rasche. Since by their nature S&T indicators require the definition of measurement standard, his keynote aims at better understanding the socio-political and organizational processes which might influence the choice concerning standards, for example on how performance of research organizations is measure. This is a central issue for the STI community.
Keynote 3. Trapped by Information: Performance Rank Ordering and Red Queen Imitation

Joseph Lampel, Manchester Business School, Manchester

Friday 4th of September, 9.00, Auditorium

Joseph Lampel worked extensively in the area of strategic management and on the implications of performance measurement (and its ambiguities) for decision-making processes within organizations. Therefore, it deals with a central issue for the STI community, i.e. understanding implications and use of performance measurement (for example international rankings) for research organizations.
Special session on the dynamics of standards

Thursday 3rd of September, 14.00 - 15.45, Auditorium.

This special session will aim at promoting a collective and interdisciplinary reflection on how standards are constructed and adopted in evaluation processes and on their implications for the outcome of evaluation and the behaviour of actors. The session will move from some recent documents on standards like the Leiden Manifesto, recently published by Nature, and the Independent review of the role of metrics in research evaluation commissioned by the Higher Education Funding Council for England.

The panel will be introduced by a keynote speech on Standards as socio-organizational constructions by David Seidl, University of Zurich.

Chair: Paul Wouters, CWTS, University of Leiden.

Participants:

- Jordi Molas Gallart, INGENIO, CSIC and Polytechnic University of Valencia.
- David Seidl, Chair of Organization and Management, University of Zurich.
- Flaminio Squazzoni, Department of Economics and Management, University of Brescia.
- Klaus Zinöcker, FTEVAL and Austrian Science Fund.
Final session. Establishing an European Data Infrastructure

Friday, 4th of September, 14.00 - 15.00

The goal of the final session of the conference is to discuss perspectives and requirements for the establishment of a long-term data infrastructure in the field of research and innovation policy, as a development of the RISIS infrastructure action. This will concern both substantive dimensions concerning the type and characteristics of datasets to be integrated, methodological and technical issues concerning integration and interoperability and, finally, management and organizational issues.

The session will take stock from the current RISIS experience, but also from experiences in other domains of social science data like the establishment of a Consortium of European Social Science data Archive (CESSDA) and the Swiss FORS foundation.

Chair: Monica Gaughan, Arizona State University, member of the RISIS project review board.

Participants:

- Peter Farago, Director, Swiss Center for Expertise in Social Sciences FORS, University of Lausanne.
- Philippe Larédo, University of Paris Est, coordinator of the RISIS project.
- Peter van den Besselaar, Free University of Amsterdam, RISIS co-coordinator.
- Matthew Woollard, Vice Chair of the CESSDA Board of Directors.
Panel sessions

Panel 1. Exploring the potential of qualitative and mixed methodological techniques in Research Evaluation

Wednesday, 2nd of September, 15.15 – 16.30. Room 355.

Chair: Gemma Derrick, Brunel University London.

- Paul Wouters, CWTS, University of Leiden.
- Sarah de Rijke, CWTS University of Leiden.
- Jordi Molas Gallart, INGENIO, Valencia
- Ingeborg Meijer, CWTS, University of Leiden.

The aim of this special session is to discuss how qualitative and mixed methodologies can be utilised to address emerging questions in the research evaluation, and science policy field. The discussion will be generated by hosting a panel involving a number of expert discussants and research leaders from the field. In addition, audience members will be encouraged by the convenor to ask the panel questions surrounding 3 main topics (described below). Through the discussion elicited by this panel, we aim move towards establishing a conduct of best practice in the adoption of qualitative and mixed methods techniques for research evaluation research. This session will form part of a larger initiative, currently funded by a British Academy Rising Star Engagement Award that aims to establish an international network of researchers interested in promoting the application of excellent qualitative and mixed methodological approaches for the research evaluation field. An international workshop exploring the application of alternative methodological tools to the research evaluation and policy field will be hosted at Brunel University London, in October 2015.
Panel 2. Indicators on careers

Wednesday, 2nd of September, 15.15-16.30. Auditorium.

Chair: Sybille Hinze, IFQ, Berlin.

- Sophie Biesenbender, IFQ Berlin, The effects of mobility and employment conditions on career progression of researchers in Europe.
- Carolina Cañibano, INGENIO [CSIC-UPV], Valencia, Scientific career phases and the mobility of European researchers.
- Chiara Franzoni, Polytechnic of Milan, Monitoring international mobility: recent approaches. The example of GloBSci.
- Monica Gaughan, Arizona State University, The impact of origin and timing of scientific immigration to the United States on scientific careers.
- Aldo Geuna, University of Turin, International careers of researchers in biomedical sciences: A comparison of the USA and the UK.

Human resources are essential for the development of national and international science system(s). Promoting research careers is high on the agenda of national and international science policy actors. However, internationally comparable research career structures are lacking and little is known about researchers’ careers in an internationally comparative perspective. Despite best efforts, a monitoring system that provides internationally comparable data and indicators about research careers does not yet exist. To date information on researchers’ careers is mainly collected on a national, institutional or organisational level, without a common homogenised standard. Only recently some projects aiming at harmonising future studies on researchers’ careers have been initiated. The situation is similar when it comes to specific factors perceived to be influential on researcher careers such as researcher’s mobility. To date we still lack consensus on how to measure and operationalize “mobility” (Cañibano et al., 2011); consequently, even though researcher mobility has been the subject of many studies, its effects on researcher careers have not yet been sufficiently and satisfactorily addressed. Based on the evidence from different studies on researcher mobility the panel sets out to address these methodological drawbacks and discuss potential options to overcome them such as the development of a theoretical framework which could enable the
systematic transnational comparison of data by harmonising and integrating available datasets.
Panel 3. Towards Standardisation, Harmonisation and Integration of Data from Heterogeneous Sources for Funding and Evaluation Purposes

Thursday, 3rd of September, 9.00 – 10.30, Auditorium.

Chair. Wolfgang Glänzel, KU Leuven and Hans Willems, The Research Foundation – Flanders (FWO), Brussels, Belgium.

- Wolfgang Glänzel, KU Leuven, Data collection and Use in Research Funding and Performing Organisations. General Outlines and First Results of a Project Launched by Science Europe.
- Sophie Biesenbender, iFQ, Berlin, Standardising Research Information in the German Science System – The Development of a Research Core Dataset.
- Gunnar Sivertsen, NIFU Norway, The integration of bibliographic data, institutional information systems and national data sources for the purpose of funding and evaluation. The latest developments in the Scandinavian countries.
- Cinzia Daraio, Ontology project, DIAG Sapienza University of Rome, An ontology of Multi-Dimensional Research Assessment for integrating heterogeneous scholarly data sources.

Funding and performing organizations and other entities use data from heterogeneous sources for evaluating research performance or allocating funding. Data on research and technology output, scientific personnel and research projects that are collected and obtained using various approaches including centralised and decentralised, top-down and bottom-up, open and propriety data. Furthermore money for financing research, innovation and technological development is spent at various levels, ranging from supranational organisations over governments down to the regional and local, intra-institutional level. Appropriate quality of these data, compatibility, interchangeability as well as their connectability with related data is increasingly a need and necessary criterion. Well-definition, suitability for indicator building and reporting and the various application purposes are the determinants in the process of standardisation, harmonisation and integration. But this is also the reason why full
compatibility cannot be imposed and complete concordance of structures cannot be granted.

For this session we have collected four contributions that will report a European initiative and national efforts (within Europe) in data standardisation and integration. Different approaches are outlined that will hopefully show new perspectives and plot roadmaps of these processes but might also point to challenges, caveats and possible limitations. We also hope that the presentations will inspire, even provoke a broad discussion about this necessary but difficult path laying ahead.

The first contribution by a task group launched by Science Europe within the working group Research Policy and Programme Evaluation reports on the first results of a survey on “Data collection and use in research funding and performing organisations”. This is followed by a report on standardisation of research information within the framework of German federal standardisation project for research information. The third contribution using the example of Scandinavia is focussed on the aspect of data integration in the context of national current research information systems. The last presentation finally introduces the Italian ontology project that aims at providing the groundwork, platform and tool for the efficient integration of heterogeneous data for the purpose of research assessment.

The presentations are followed by a broad panel discussion with the participation of the speakers and the attendees of this special session.
Panel 4. Research Responsible Innovation
Wednesday 2nd of September, 13.45 – 15.15, room 355

Chair: Emanuela Reale, CNR-IRCRES, Rome.

- Richard Woolley, INGENIO, Valencia.
- Carter Bloch, Aarhus University.
- Philippe Larédo IFRIS, Univeristy of Paris Est.
- Ingeborg Meijer, CWTS, Leiden University.

Responsible Research and Innovation (RRI) gained a momentum in Science Technology and Society (STS) studies from 2011, when a Workshop promoted by the DG Research to building the notion of Responsible Research and Innovation in Europe (EC 2011), ended up with the concept of responsiveness of research and innovation to society in the face of the uncertain effects that can be produced, and the need to make the motivations and the intentions for actions in research and innovation (R&I) more democratic. The Rome Declaration in 2014 put an emphasis on the role of actors in science and innovation systems (governments, funding agencies, research organizations, research groups) to promote responsibility in research practices. Thus, RRI is now an emerging challenge at national and European level for the governance of science, whose realization is likely to affect also research institutions and organizations.

The round table wants to promote a debate on the institutionalization of RRI in public research organizations, Universities first and foremost, and their evaluation with new questions, which require new criteria and indicators. In this respect new conceptual and methodological approaches and metrics are discussed.
Abstracts of paper presentations

Citation preference in the German science system

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Session on Bibliometrics and citation analysis, Thursday 3rd of September, 16.00 – 18.00, room 355.

Background and Purpose
The purpose of the study is to analyse citation preferences within the German science system.

Research organizations in Germany include primarily higher education institutions and non-university research institutions. Higher education institutions refer to government-funded and private universities, universities of applied sciences and other academic institutions. In contrast, non-university research institutions are publicly funded and not directly involved in academic teaching. They include, among others, the four major research organizations: Fraunhofer Society, Helmholtz Association, Max Planck Society, and Leibniz Association. The aim of the paper is to reveal preference structures of a single research organization towards other organizations with regard to their referencing and citation behaviour.

Data and Methods
The data originate from an in-house database of Thomson Reuters’ Web of Science. The analyses of publications and citations are restricted to the Science Citation Index-Expanded (SCI-E) and the Social Sciences Citation Index (SSCI) and journal publications of the document type article, letter, and review. The identification of publications is based upon the address coding for all German addresses in Web of Science (Winterhager, Schwechheimer & Rimmert, 2014). Papers are assigned to research organizations on the basis of their affiliation. The following research organizations can be distinguished within the database and are in the following referred to as ‘sectors’:
1) **FhG** (*Fraunhofer Society*) institutes have a technical focus and cover areas of information and communication technology, life sciences, surface technology and materials.

2) **HGF** (*Helmholtz Association*) is the largest scientific organization focusing on research areas such as aeronautics, computer science, energy, health and biotechnology. Different from *Fraunhofer Society* their research orientation is basic as well as applied.

3) **MPG** (Max Planck Society) conducts basic research in the natural sciences, life sciences, social sciences and humanities. Their mission is fundamental research in newly emerging fields complemented by large equipment and outstanding research facilities.

4) **WGL** (*Leibniz Association*) institutes are engaged in the natural sciences, engineering and environmental sciences, but also in economics, social sciences and the humanities.

5) **HS** (Universities) include 106 universities.

6) **FH** (Universities of applied sciences) include 212 universities of applied sciences.

Whereas the main focus of universities is on research in science, social and behavioural sciences, arts & humanities and medicine, universities of applied sciences have their focus on mechanical engineering, mechatronics, computer science and business & management. According to Mund, Conchi & Frietsch (2015) the sector FH accounts for 1% of all German papers, whereas the HS sector contributes two-thirds to Germany’s total scientific publication output.

7) **Others** include hospitals, companies, enterprises, etc.

8) **Int** refers to international publications (all non-German publications).

Citations received by the publications of a sector were determined for the publication period 2003-2005 and 2009-2011 and a citation window of three years.

Schubert & Glänzel (2006) created *preference indicators* on country-level, which measure the preference without the effect of, e.g., size of scientific
output. In the present paper we deal with organization-to-organization relations of the German science system, with the specific citation preference of distinct research organizations towards each other, expressed by cross-citation indices. The applied “citation preference”-indicator by Schubert & Glänzel (ibid.) captures a “specific affinity” to cite other research organizations. The citation-preference matrix is represented as a $k \times k$ matrix with $k$ being the number of research sectors. The citation-preference index is the share of the citations of a sector $i$ from sector $j$ in sector $i$’s citations divided by the share of sector $j$’s references in world’s total references. (cf. Schubert & Glänzel, 2006, p.412). Values $> 1$ mean affinity, whereas values $< 1$ express neglecting. The matrix was constructed for the seven German research sectors and all non-German papers both for the 2003-05 period and the 2009-11 period.

**Results and conclusions**

Table 1 presents trends in citation preference. Values $< 1$ indicate a loss in citation preference, whereas values $> 1$ reflect growth in preference. The highest value can be found for WGL-HGF. The HGF more and more relies on publications by the WGL (1.77) and on those by FhG (1.56). The FH increased the share of references to FhG (1.07) at the expense of other sectors. The citation preference is not mutual, since the FhG-FH trend-index is only 0.33. MPG is the sector that has attracted citations from all other sectors, except for FH. MPG and FH are diametric in their research orientation, MPG representing fundamental research vs. FH being active in applied science. None of the sectors increased their preference to cite international publications.
Table 1. Trend in citation preference between the 2003-2005 and the 2009-2011 period.

<table>
<thead>
<tr>
<th>Trend</th>
<th>FhG</th>
<th>HGF</th>
<th>MPG</th>
<th>WGL</th>
<th>FH</th>
<th>HS</th>
<th>Other</th>
<th>Int</th>
</tr>
</thead>
<tbody>
<tr>
<td>FhG</td>
<td>0.59</td>
<td>1.56</td>
<td>1.11</td>
<td>0.69</td>
<td>1.07</td>
<td>1.16</td>
<td>1.17</td>
<td>1.00</td>
</tr>
<tr>
<td>HGF</td>
<td>1.36</td>
<td>0.74</td>
<td>1.00</td>
<td>1.22</td>
<td>0.71</td>
<td>1.09</td>
<td>0.87</td>
<td>1.02</td>
</tr>
<tr>
<td>MPG</td>
<td>1.02</td>
<td>1.11</td>
<td>0.92</td>
<td>1.01</td>
<td>0.84</td>
<td>1.15</td>
<td>1.10</td>
<td>1.01</td>
</tr>
<tr>
<td>WGL</td>
<td>0.85</td>
<td>1.77</td>
<td>0.96</td>
<td>0.75</td>
<td>0.62</td>
<td>1.13</td>
<td>0.81</td>
<td>1.01</td>
</tr>
<tr>
<td>FH</td>
<td>0.33</td>
<td>0.73</td>
<td>0.85</td>
<td>0.68</td>
<td>0.39</td>
<td>1.15</td>
<td>0.83</td>
<td>1.03</td>
</tr>
<tr>
<td>HS</td>
<td>1.21</td>
<td>1.23</td>
<td>1.17</td>
<td>1.13</td>
<td>0.93</td>
<td>0.94</td>
<td>0.94</td>
<td>1.03</td>
</tr>
<tr>
<td>Other</td>
<td>1.19</td>
<td>0.89</td>
<td>1.15</td>
<td>0.85</td>
<td>0.71</td>
<td>0.98</td>
<td>0.81</td>
<td>1.01</td>
</tr>
<tr>
<td>Int</td>
<td>0.83</td>
<td>0.95</td>
<td>0.91</td>
<td>0.89</td>
<td>0.78</td>
<td>0.87</td>
<td>0.83</td>
<td>0.93</td>
</tr>
</tbody>
</table>

Citation preference proves to be a meaningful indicator to detect preferences in citation behaviour among research organizations. The indicator is normalized and compensates for size effects, which is important with regard to a sector’s scientific output. The citation-preference indicator reveals that an intense citation preference exists between sectors with similar orientation, thus the application-oriented sectors on the one hand, and those with a focus on basic research.

References


Is the most innovative research being funded?
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Session on Funding and its impacts on research groups and individuals Wednesday 2nd of September, 13.45 – 15.15, room 355.

Introduction
Is the most innovative research being funded? This study examines this question using research communities from a detailed and comprehensive model of the scientific literature and funding data. In a previous study, we illustrated how one can identify those few research communities that are emergent (Small, Boyack, & Klavans, 2014). We expand upon this by proposing a life-cycle model for all research communities. In addition, we develop a composite indicator of the innovativeness of a research community, and correspondingly assign each community to a life-cycle stage. Innovativeness, based on 2010 data is then correlated with STAR METRICS® funding data from the United States (2008 and 2013 data). We find that the most innovative research communities are far more likely to be funded than less innovative communities, and their future funding (i.e., in 2013) is likely to increase. The least innovative research communities receive less funding and experience a drop in funding over time. For the funding agencies included in STAR METRICS®, there is a strong preference for funding highly innovative research communities and cutting funds for those research communities that are not innovative.

Analysis and Results
A model of all of science was created from the full (1996-2012) Scopus database with the smart local moving algorithm of Waltman & van Eck (2013) using the method described in detail in Boyack & Klavans (2014). Direct citation was used to partition over 48 million documents into 91,726 research communities. The size distribution of research communities is very similar to the size distribution of cities in the U.S. Thus, each community can be designated as a research city, research town, or research village based on size. Research cities can be thought of as communities that are participating in Big Science, while towns and villages comprise what we
might think of as Little Science. Autocorrelations in growth rates suggest a strong differentiation between Big Science and Little Science. Citation growth rates were calculated for two time periods (2008-2010 and 2010-2012) for each community. There was a strong negative autocorrelation (Pearson correlation = -0.431) between the two growth rates for the entire sample of over 90,000 research communities. However, the autocorrelation is 0.382 the Big Science research communities, suggesting that Big Science and Little Science operate under different dynamics, and can be considered separately.

Composite indicators of innovativeness were created independently for the Big Science and Little Science groups to illustrate the differences in evolution in these two groups. For each group, six indicators were used in an ordinary linear regression to generate the composite indicator. The six indicators are the number of hot papers, degree of collaboration, community age, community self-citation fraction, vitality, and community size. Average citations per paper (as of 2012) by cluster were used as the dependent variables to generate coefficients in the regression equations, and the resulting equations were used to calculate the composite innovativeness index. The most important variables for Little Science communities are self-citation and size. Self-citation is negatively correlated, suggesting that small communities that are highly insular tend to have low impact, and thus a low chance to be innovative. The number of hot papers is also very important. Without significant advances, small communities have little chance of being innovative. The mix of important variables for Big Science is different from that of Little Science. Although community self-citation rate is still important, the two variables next in importance are vitality and community age. Hot papers and size are less important because these communities have already experienced growth in these factors to become Big Science communities.

With the result that Little Science and Big Science can be modeled independently, we have created a life-cycle model that includes 6 stages – 3 for Little Science and 3 for Big Science – and have identified the appropriate stage for each community. For Little Science, increasing stage is associated with an increasing probability that the community will become innovative. For Big Science, increasing stage is associated with decreasing
growth and decreasing innovation. Stages 3 and 4 are where one finds ‘hot topics’, and correspond roughly with the notion of emergence.

The next step in our analysis was to correlate funding with life-cycle stage. Specifically, we linked funding data from STAR METRICS® (a collaborative effort among many U.S. government agencies that has created a deposit of data on federal R&D investments) to the research communities in our model of science. This was done using word profiles generated for each research community, and matching the word profile for each grant (from titles and abstracts) to the communities it most closely resembled. Matching was limited to those communities with authors from the U.S. Grant totals of $31.8 billion for 2008 and $30.2 billion for 2013 were assigned to 16,595 research communities using this method. Approximately 60% of these grants went to Big Science during these two time periods (59.0% in 2008 and 59.8% in 2012). Table 3 summarizes the essential findings from this study.

Stage 1 consists of the 85,428 small research communities that had very low levels of innovativeness. There was a sizable drop in funding to stage 1 communities from 2008 to 2013 (from $9.43B to $8.38B), as well as decreases in the funding per community (from $800k to $710k) and funding per U.S. author (from $65k to $56k). One can see that the funding per community increases dramatically as one moves from stage 1 to stage 2 and to stage 3. One can also see that funding per community increases from 2008 to 2013 for stages 3 and 4, while it decreases for the other stages. Thus, the composite innovation indicator generated using 2010 data does an even better job of placing money in the most innovative stages using forward funding data (2013) than retrospective funding data (2008). While this is not truly predictive, it is nonetheless noteworthy that the composite indicator correlates so well with forward funding data.

References

Application of an “interdisciplinarity” metric at the paper level and its use in a comparative analysis of the most publishing ERA and non-ERA universities

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Session on The dynamics of research fields
Thursday 3rd of September, 10.45 - 12.30, room 355.

Introduction
Empirical research results have shown a slow upward trend, over the years, towards research that cross disciplinary boundaries (Porter & Rafols, 2009). It has been suggested by several academics that this type of research can have positive effects on the production of new scientific knowledge. Governments are thus fostering this type of research and are interested in monitoring the progress towards it and in documenting its effects on the research and innovation (R&I) system.

Various subdimensions of cross disciplinary research are reported in the literature (Wagner et al., 2011). This paper deals with interdisciplinary collaboration, which involves that the knowledge of various disciplines is integrated through the joint work of researchers in different disciplines to address a problem that is generally beyond the scope of any one discipline. The “interdisciplinarity” metric implemented here is based on the disciplinary mixture of a paper’s cited references, and not on the disciplinary mixture among the departmental affiliations of a paper’s authors. Because of that, it is assumed that it reflects the extent to which the reported work truly integrated knowledge from different disciplines as scientists from various disciplines could work together without integrating knowledge. However, the knowledge integration detected with this metric
could result from the work of a single scientist (i.e. collaboration is not necessary).

**Methods**

The study was done using Elsevier’s Scopus database. The integration metric of Porter & Rafols (2009) was applied to quantify the diversity (i.e. variety, balance and distance) of disciplines integrated in a single paper, for all papers in Scopus. It consists of measuring the diversity of disciplines in which the cited references of a single paper are classified relative to a reference set of papers. The disciplines (or subfields of science) used in computing this metric are taken from Science-Metrix’s mutually exclusive classification tree of scientific journals. The “interdisciplinarity” of each paper within the database is thus measured by comparing the frequency distribution of subfields within its references to a proximity matrix between scientific subfields (pairwise similarity of subfields based on their co-occurrence patterns within the references of individual scientific papers in the database as a whole). This approach allows for giving more weight to unusual co-citation patterns relative to those that are very common. Applying this computation method, each paper have received an “interdisciplinarity” value ranging from 0 (monodisciplinary) to 1 (highly interdisciplinary). Subsequently, the “interdisciplinarity” of an entity (a researcher, a country, etc.) can be obtained by averaging the scores of its papers or by computing the proportion of its papers falling within the 10% most “interdisciplinarity” papers in the database.

The main difficulty with this approach concerns the limitations in the citation coverage. Only a fraction of a paper’s total references are indexed in Scopus, and this fraction is not uniformly distributed across years and scientific subfields. Since we observe a relationship between the number of classified references and the average “interdisciplinarity” score of papers, important biases could prevail using the average of the “interdisciplinarity” scores of an entity’s papers when measuring the extent to which its research crosses disciplinary boundaries. Indeed, this study showed that “interdisciplinarity” scores increase rapidly from papers having 0 to papers having 30 classified references. After that threshold, the scores present a slight and linear increase. To cope with this issue, a threshold for the minimum number of classified references was set for a paper to be considered in computing the aggregated “interdisciplinarity” score of an
entity. This was achieved by looking exclusively at the 1% of papers having the largest number of references in each subfield. This threshold ensured that very few papers in any subfield would have less than 30 classified references and that all subfields were represented proportionately to their overall occurrence in Scopus. To get the aggregated “interdisciplinarity” score of an entity, the proportion of its retained papers falling in the 10% of papers with the highest “interdisciplinarity” score (i.e., scores of at least 0.70) was computed when at least 100 papers are available. A downside of this approach is that the “variety” aspect of diversity (i.e. number of distinct disciplines in the references of a paper) might be given less weight than the “balance” and “distance” aspects since papers with few references are omitted.

Results and discussion
When aggregating data by year, one can see that “interdisciplinarity” is increasing over time. At the turn of 2010, 10% of all retained papers in the Scopus database show an “interdisciplinarity” score of 0.7 or higher. Three main domains of science score above expectations (i.e., have more than 10% of their papers with an “interdisciplinarity” score of 0.7 or higher), namely the arts & humanities (18.2%), the economic & social sciences (15%) and the applied sciences (13.2%); similar results are obtained using a different normalisation technique to correct for the biases of the database.

Apart from the SSH, the applied sciences represent the only other domain in which the proportion of highly “interdisciplinary” papers is above expectation. This finding might suggest that research drawing on a broad range of a priori disconnected knowledge can indeed spur the emergence of novel technologies as applied research is closer to innovation than the more fundamental research. Additionally, technical universities appear to be over-represented among universities having a greater proportion of highly “interdisciplinary” papers and this is mostly attributable to technical universities within the ERA than to those outside the ERA. Yet, ERA universities did not do as well as generally as non-ERA universities. Again, the findings are coherent with those obtained using a different normalisation technique to correct for the biases of the database. Nevertheless, the strong limitations of this indicator, as they are depicted in this paper, call for more research on “interdisciplinarity” metrics. This is especially true for applications such as the ranking of entities be it organisations or countries.
References

My interdisciplinarity à moi. An analysis of neuroscience research in French Universities, 2008-2012

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Session on The dynamics of research fields
Thursday 3rd of September, 10.45 - 12.30, room 355.

The aim of this paper is to analyse the degree of interdisciplinarity of the research in neuroscience in French universities over the period 2008-2012. The paper is an application of the analytical framework proposed by Cassi et al. (2014) to study interdisciplinarity at the institution level. The present work, which is the result of interactive process involving representatives of university management teams, shows how the comparison of interdisciplinarity indexes of different institutions in a research domain could be used to provide quantitative evidence on the different institution strategies.

A global index for the interdisciplinary of an institution

Interdisciplinarity can be defined as the integration of knowledge, theories and methods from different disciplines, more or less distant from an epistemological perspective. Following a part of the literature (Porter & Rafols 2009, Rafols & Meyer 2010), we use a measure of the diversity of the disciplines of the references as an indicator of the interdisciplinarity of the institution in a domain. As developed in a former work (Cassi et al., 2014), the widely used Rao-Stirling diversity index (Stirling, 2007) is able to measure interdisciplinarity at different scales. We explore here how two decompositions of a global interdisciplinarity index can provide some relevant information on interdisciplinary practices of institutions.
More insight on interdisciplinarity through two decompositions of the index
In the case when an institution has a larger global interdisciplinarity index than a benchmark, it is possible to determine whether this higher value is due to the diversity of references in each publication – an interdisciplinarity within publication – or to the diversity of the disciplinary profiles of references between the publications, or to both practices.

Another issue when the global index of a corpus is large compared to its world counterpart, is to find which disciplines are more cited by the institution than what is normally done. It is possible to split the global interdisciplinarity index into discipline contributions and to provide comparative profiles of interdisciplinary collaborations.

Interdisciplinarity practices of French universities in neurosciences
This study reveals a diversity of strategies and practices in terms of interdisciplinarity. It allows identifying universities which develop a wide variety of themes in various institutes or teams, leading them to cover the discipline in a richer way than the world standard. Such a university may have a level of within publication interdisciplinarity equivalent to the world average - as does Paris 5 University - or higher than this average, as Nantes and Paris 7. Universities which have a modest investment in the discipline can target their research effort towards collaboration with other fields, as in Nantes. Another strategic option for these universities is to develop a specialized component in relation to its excellence areas as the University of Grenoble 1 does with imaging technology and computer analysis. Finally, universities that have heavily invested in this area as Aix-Marseille may have a strategy focusing on advanced research on specific topics where its research teams could be leader.

Figure 1. Within and between interdisciplinarity indexes of eight French universities in Neuroscience
References


Designing the Economic Benefits Assessment Framework of Taiwan’s Portfolio of Biotech Programs and Realigning the Quantitative Indicator System

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Session on Innovation and emerging technologies
Thursday 3rd of September, 09:00 – 10.30, room 355.

Corresponding to global science policy transition from basic science and defense to societal needs which turn to emphasize the application and problem-solving, Taiwan’s Ministry of Science and Technology (MOST) launched several large-scale, interagency, and application-oriented science programs organized under the umbrella of National Science and Technology Program (NSTP).

With the growing accountability pressure toward the state-funded S&T programs by the parliament and the public, Taiwan’s MOST in charge of the management and evaluation of the science programs implemented by multiple ministries began to delegate some in-depth evaluations concerning large-scale portfolio of S&T programs (NSTP) to the third-party institute such as the state-funded Science and Technology Research and Information Center (STPI).

Among the NSTPs, the National Research Program for Biopharmaceuticals (NRPB) is composed of a portfolio of medical programs designed to address the health problems through public R&D investment. Therefore, the economic impact assessment of the NRPB should not be confined to the measurement of the benefits through technology commercialization trajectory of the NRPB in response to the primary concerns by the parliament, but rather be extended to the measurement of the benefits to the society (the health gains).

Besides, when designing the economic impact evaluation framework of the NRPB, we ought to assess the availability of the reported performance data. Technically, indicator monitoring is supposed to be aligned with program
evaluation. The continuous monitoring indicators, data collection, and indicator construction based on the collected data can support the evaluation as well (Ruegg & Jordan, 2007). However, Taiwan’s current performance indicator reporting system of science programs is in lack of well-specified, operationalized definitions of economic and social impact measurement, and its underlying rationales is not aligned to specific program impact evaluation framework.

Therefore, the alignment of the selection and adaptation of current reported indicators of science programs to the specific data collection strategy required by the well-conceived in-depth impact evaluation approach motivate this paper. This paper serves as an pilot study to design a feasible analytical framework to measure the private and social benefits by reviewing the different economic impact analysis methodologies, available data constraint under the current indicator system, evaluation timeframe, and resource-and-time constraint. Therefore, its findings can consequently feedback into the further modification of the current quantitative indicator reporting system of Taiwan’s science programs with better specified definitions and underlying rationales, more comprehensive benefits coverage, and more sophisticated data collection strategy in support of the impact evaluation.

In the first part of the paper, I scrutinized the availability and constraints of the current quantitative indicator reporting system. The totaled 31 sub-category of Taiwan’s current performance indicator reporting system of science programs are primarily divided into 5 dimensions: “Academic Achievement”, “Technology Innovation, Industrial Promotion”, “Social Impact”, and “Science Policy and Management”. Under each dimension of indicators are several related indicators. Concerning the impact evaluation, we use some examples to illustrate the reasons why current indicator reporting system is insufficient to measure and calculate the economic benefits from the economic benefits assessment rationales such as their ill-defined causal linkages traceable to research output of the programs.

In the second part of this paper, I compared the the feasibility of adopting different economic benefits assessment approaches (Griliches, 1958; Mansfield, 1998; ATP, n.d.; SRI International, 2008; Jacob & McGregor, 1997; Mushkin, 1979; National Research Council, 2005) to assess the
economic benefits of NRPB in terms of their benefits diffusion channels, stakeholders, and data collection strategies. The benefits measured by the scrutinized economic analysis frameworks can be divided into three major benefits:

Producer surplus resulting from the cost reduction by innovation for the firms participating in the research program

Consumer surplus (markets spillover) resulting from the cost reduction by innovation for the public as consumers

Spillover benefits such as health gains for the public beyond the commercialization market, and knowledge spillover for the non-participant firms and researchers

The benefits characterized above include the benefits of government R&D investment as science policy investor and science policy consumer as well. This paper rule out the consumer surplus benefits due the data availability and double-counting problems.

Finally, I propose an economic impact assessment framework comprising “Benefits for the Firm”, “Benefits for the Innovation System”, and Benefits for the Society” where several quantitative indicators are employed to measure the economic benefits such as additional product sales, induced cluster benefits, induced public-private co-funding, knowledge spillover, increased employment, and health gains, etc.

Through the perspectives of economic benefit assessment rationales, this paper provide the insight into the inadequacy of current quantitative indicator of science programs in supporting the economic impact evaluation of the NRPB, and envisioned the prospective restructuring direction for the current indicator reporting system. Given that Taiwan’s reporting agencies’ impact evaluation capacity is limited and the indicator selection process is voluntary, the impact indicator construction should be well-specified in the guidance manual with clear underlying impact assessment rationales, data collection strategy. By doing so, some of the performance data such as the “Increased Employment” might either be collected through retrospective attribution or secondary data or be estimated through other estimation approaches such as linear regression based on the research output data of
the programs without solely relying on the self-reporting of the science agencies.

For the NRPB of Taiwan, the estimation of intangible benefits regarding the in-kind technology service and the health gains can more comprehensively capture the whole picture of the tangible and intangible benefits involved by the NRPB without underestimating its benefits and misleading the evaluation and further decision-making. Through the proper attribution and value estimation, the economic impact analysis underpins the justification for the governmental intervention, the determination of proper research expenditure level, and the feedback into the future decision-makings to maximize the research benefits.
The impact evaluation scale: Group panel processes and outcomes in societal impact evaluation

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Session on Evaluation and its outcomes
Wednesday 2nd of September, 11:00 -12:30, auditorium.

Introduction

Whereas a number of conceptual models and theories have been proposed to understand the process of impact realisation and, in turn, guide its evaluation by peer review panels, actual empirical investigations of the assessment of societal impact, where the results are linked to funding outcomes are rare (Bornmann, 2012, 2013; Holbrook & Hrotic, 2013). Indeed, without a strong precedent for formal, reflexive, ex-post evaluation of societal impact, questions remain about how evaluators would navigate the peer review process and resolve their values about what constitutes excellence in the societal impact. Further, problems associated with access to peer-review panel deliberations, and a lack of formal frameworks incorporating criteria of the societal impact of research, have made conducting this type of empirical research difficult.

This research provides the first empirical study of societal impact evaluation, by exploring UK Research Excellence Framework (REF2014) evaluator values and opinions about the process of assessing societal impact. Two intertwined, semi structured interviews (one before the evaluation process began (pre-evaluation interview); and the other after the evaluation process was complete (post–evaluation interview)) were conducted with 62 REF2014 evaluators from the health, medical and biomedical fields. Themes expressed by evaluators during interviews concerning the societal impact and its method of assessment were compared before and after the evaluation process, in order to gain an understanding of the process of societal impact evaluation during peer review panel deliberations.
Results

In the first round of interviews (the pre-evaluation interview) evaluators described their inexperience when dealing with societal impact assessment, and this inexperience led to a number of values and ideas about the value of different societal impacts being weighed against each other during the assessment process. The evaluators showed a variety of values, views and beliefs about societal impact (“I’m still not convinced everybody shares exactly the same definition of what constitutes impact or where they place the weight of it or if it’s impact or isn’t” P3Imp1), including a strand of uncertainty which was often expressed explicitly; “I’m very happy to describe the quality of the research [but] the valuing of impact is something I have no idea about” P0P2OutImp1. The newness of the criteria highlighted that the assessment of societal impact or the “impact stuff” made evaluators “nervous” as distinct from the more traditional modes of research assessment were “what we cut our teeth on”.

After the evaluation process, evaluators expressed a moderate change in their conceptualisation of impact that, at times, ran counter to the existing guidelines designed to aid the evaluation process. In some cases, evaluators expressed how that they felt restricted by the 4 star upper limit imposed by the assessment guidelines where, in many cases some impact was assessed as 4 star, but that “others were definitely 10 star”. This implies that, as hypothesised from the pre-evaluation interviews, that assessment panels placed a value on some types of societal impacts, over others. In particular, evaluators described how they acted “generously” in the assessment of impact, due, in part, to the political nature of the research evaluation process that emphasised a desire to “showcase” the value of science to the wider, non-academic audience. However, due to the evaluator’s relative inexperience and a lack of an evaluation precedent when it comes to societal impact evaluation, evaluators needed a “purpose” for assessment. Therefore, the “generous” guideline to “showcase the research” gave evaluators the necessary liberty to step outside their traditional evaluation precedent of evaluating the scientific impact of the research.

In this paper we test the conceptualisation of the impact evaluation scale that was constructed as a result of the pre-evaluation interviews. Specifically, two different modes of evaluation – the “quality-focused
evaluation” and the “societal impact-focused” were used to represent two extremes of considering how evaluators might assess impact, thereby providing a lens with which to view the group panel assessment process of societal impact. The different beliefs evaluators had about the evaluation of societal impact influenced where they positioned themselves along the scale. These decisions when considered together formed a dominant definition of societal impact that influenced the direction of its evaluation by the panel. This dominant definition could be ascertained through the post evaluation interview results, and how it was utilised by the panel to guide the evaluation. In addition, considering evaluators’ views about societal impact using the evaluation scale aids the discussion of the tensions faced by evaluators regarding the valuation and conceptualisation of societal impact for assessment.

References


Where has Canadian Federal Funding gone? Using Latent Dirichlet Allocation for Analyzing Research Trends of Funded Researchers

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Session on Funding and its impacts on research groups and individuals
Wednesday 2nd of September, 13.45 – 15.15, room 355.

It was after the Second World War (WWII) when several developed countries started to devote more financial resources to research and development (R&D). Nowadays, large amount of money is being invested annually in R&D activities to foster scientific development. Scientists publish their results in the form of scientific papers to secure their priority in discoveries (De Bellis, 2009), in return to the funding that they have received. On the other hand, the nature of modern science has become more interdisciplinary, complex, and costly than before that forces researchers to get involve in larger scientific teams and collaborate more (Lee & Bozeman, 2005). Hence, the current characteristics of science can be regarded as one of the factors that foster collaboration among researchers. Higher collaboration, increasing number of researchers world-wide and tighter competition for the limited financial resources are some of the reasons that have caused a continuous increase in the number of publications over the past years. Hence, apart from the need for a systematic performance evaluation of the funded researchers analyzing the research projects and their trends looks necessary for the funding agencies to make sure that the projects are in accordance with their goals.

Although the exponential growth of data in the digital era has provided the research analysts with the required material, the complex highly
Dimensional big data has made the analyses so challenging in a way that traditional methods look no longer suitable. However, complex computer based algorithms provide researchers with novel opportunities to explore new directions of the information science as well as scientific evaluation. One of the machine learning techniques that can be applied for this purpose is called clustering. Clustering that is widely in use in various scientific fields and applications (e.g. bioinformatics, image segmentation, and document summarization) is an unsupervised learning technique that discovers the hidden groupings in a dataset. Topic modeling is a clustering technique in which a collection of documents are automatically organized into a set of clusters (topics). Clustering large quantities of text has several unique challenges comparing to non-text data mining tasks. The two main concerns are the highly unstructured nature of the text data that requires encoding to be converted to a form that is recognized by clustering techniques, and the high dimensionality of the encoded data (Millar et al., 2009).

Despite the challenges, topic modeling has been widely used in several studies for automatic extraction of the semantic or thematic topics from large corpus of documents (e.g. Griffiths & Steyvers, 2004; Griffiths et al., 2007; Weng et al., 2010). In addition, topic modeling can be easily generalized to treat other data types, e.g. image analysis (Fei-Fei & Perona, 2005; Sivic et al., 2005), survey data (Erosheva, 2002), and biological data (Pritchard et al., 2000). The extracted topics can be used for categorizing documents in a large corpus or analyzing the trends of the research projects in a given subject. For example, Blei and Lafferty (2006) developed probabilistic time series models to analyze the evolution of topics in the journal Science within the period of 1880 to 2000. In another study, Griffiths and Steyvers (2004) focused on the abstracts of articles published in the Proceedings of the National Academy of Sciences of the United States of America (PNAS) and presented a statistical method to discover and assign a set of topics to each document in the corpus. In a recent study, Weng et al. (2010) focused on detecting the influential users of Twitter and analyzed the topical similarity between users as well as the link structures. They proposed a PageRank-like algorithm for measuring the influence of the Twitterers.
Analyzing research topics and their trends can be beneficial for both the researchers and the policy makers. The topics are one of the first things in a paper that attracts the attention of the reader. Although it is possible for scientific experts to be aware of the hot topics in their field, due to the large volume of the digital data it is almost impossible for a researcher to know all the interesting topics in all the related scientific fields or even in a particular field of science. In addition, analyzing the research topics can enable policy makers to have a clear picture of the topics that are rising or falling in popularity which may help them to direct their macro strategies towards the research priorities. This paper focuses on the Canadian researchers who have been funded by the Natural Sciences and Engineering Research Council (NSERC) of Canada and are active in natural sciences and engineering. Using Latent Dirichlet Allocation (LDA) algorithm we automatically extracted the research topics out of the publications of the mentioned researchers and analyzed the trend and evolution of the projects over the time period of 1996 to 2010. Our results confirm the accordance between the research topics and the macro policies of the country.

References


Assessing technology transfer by local public technology centers in regional and sectoral innovation systems: Insights from patent data

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Session on Innovation and emerging technologies
Thursday 3rd of September, 09:00 – 10.30, room 355.

Purpose
Local public technology centers (LPTCs) in Japan aim to help local small- and medium-sized enterprises (SMEs) improve productivity through technology transfer. They first were established as technology centers for agriculture in the late 19th century and currently spread all the prefectures, engaged in technology transfer activities in various fields, including agriculture, manufacturing, civil engineering, industrial design, environment, and public health. Key technology transfer channels are testing, use of equipments and engineer training, technical consultation, joint research, funded research, licensing, and publication. Although it has been widely recognized that LPTCs act as important sources of knowledge for local SMEs, little quantitative evaluation based on comprehensive dataset has been conducted. This study evaluates technology transfer activities of LPTCs, in comparison to universities, in regional innovation systems by examining whether knowledge creation by LPTCs corresponds to the characteristics of regional innovation systems and how knowledge created by LPTCs is disseminated in regional innovation systems.

Originality
This study contributes to the previous literature by filling the research gap in the evaluation of public innovation intermediaries in regional innovation systems. It has been considered that innovation intermediaries play two key roles in national or sectoral innovation systems: a pool of knowledge spillover (e.g., public research institutes) and a mediator of knowledge spillover (e.g., trade associations). This study is the first to provide empirical evidence on the both functions of LPTCs in regional innovation systems.
systems in terms of knowledge creation and knowledge dissemination, which enables this study to derive policy implications on the efficient design of LPTCs as regional innovation policy. Furthermore, this study contributes to the previous literature by incorporating into theoretical framework the division of labor among different types of intermediaries. In another study, the author had addressed a private innovation intermediary like SMEs’ innovation networks in regional innovation systems. This study provides evidence on the functions of innovation intermediaries that should be undertaken by the public sector because of systemic failure that hampers individuals and firms to receive knowledge spillover. This enables this study to derive implications for policy design and evaluation because efficient division of labor among public and private innovation intermediaries is important in the knowledge-based economies.

Methodology
This study uses the Institute of Intellectual Property Patent Database (IIPPD) which includes information of all the patents applied for JPO. In order to identify applicants’ firm size, this study employs the National Institute of Science and Technology Policy (NISTEP) Corporate Database (NCD). IIPPD combined with NCD enables this study to quantify technological knowledge portfolio held by SMEs, large firms, LPTCs, and universities in a region. This study employs IPC8 Technology Concordance to identify six technological fields, including instruments, mechanical engineering, electrical engineering, chemicals excluding biotechnology, biotechnology including pharmaceuticals, food engineering, and environmental technology, and others. Lastly, this study uses information of patents applied for JPO from 2000 to 2009. This study analyzes the similarity of technological knowledge portfolio between LPTCs and SMEs in a region and the types of research partners and forward self-citations and non self-citations identified through joint patents. The similarity of technological knowledge held by LPTCs and universities to SMEs and large firms is measured using cosign similarity index. Joint patents are used to identify research collaborations between firms, LPTCs, and universities. Self-citations are used to represent the co-inventor’s ongoing interest in further development of joint patents, and thus the commercialization of joint
inventions. Non self-citations excluding patent examiners’ citations are used to identify far-reaching impacts of joint inventions on the economy.

Findings
Cosign similarity between LPTCs and SMEs is 0.74 while cosign similarity between universities and SMEs is 0.69. There is a statistically significant difference between the two (p<0.05, t=2.30). Cosign similarity between LPTCs and large firms is 0.68 while cosign similarity between universities and large firms is 0.71. The difference between the two is statistically insignificant (p=0.28, t=-1.09). For LPTCs, the proportion of joint patents with local SMEs is 0.147. For universities, the ratio is 0.044 and there is a statistically significant difference (p<0.01) between LPTCs and universities. Contrary to the prediction, the probability of joint patents’ being unexamined, and self-cited by the co-inventing firm is higher when firms collaborate with universities. For LPTCs, the proportion of joint patents’ being self-cited by the co-inventing firm is 0.095 while the ratio is 0.150 for universities. The difference is statistically significant (p<0.05). The number of forward non self-citations is 4.25 for LPTC joint patents and 3.37 for university joint patents. There is a statistically significant difference (p<0.01) between LPTCs and universities. LPTCs engaged in environmental science (type E) and agriculture (type A) generate patents that have far-reaching impacts on the economy.

Research implications
The results imply that LPTC knowledge potentially spills over into innovative activities of local SMEs as LPTCs create knowledge complementary to innovations of small local firms whereas knowledge creation of universities is not embedded in regions. However, actual process of spillover seems different from what has been predicted. The results suggest the absence of preemption through collaborations between universities and large firms as self-citations by the co-inventing firm are greater for university joint patents. Surprisingly, it was LPTC joint patents, compared to university joint patents, that had further-reaching impacts on the economy. It is reasonable to find type E create high impact knowledge as they engage in research on measurement and standards which has impacts on various industries. Type A engage in research on material like yeast and enzyme where patents are the most likely to provide protection.
effectively, and which are likely to be commercialized in various industries like food and beverage.

**Practical implications**
In comparison to universities, knowledge created by LPTCs fits better with regional innovation systems, which is good news for LPTCs and local authorities. The results show that LPTCs in different sectors exhibit different patterns of knowledge dissemination, probably stemming from the differences in types of knowledge created by LPTCs. This implies that arrangement of different technology transfer channels would help improve technology transfer efficiency of LPTCs. One-size-fits-all strategy to reorganize LPTCs would be detrimental to productivity of technology transfer.
A comparative study of citation distributions of books and journal articles in three fields and implications for indicator building

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Session on Bibliometrics and citation analysis, Thursday 3rd of September, 16.00 – 18.00, room 355.

Introduction
A deeper understanding about the citation characteristics of books are needed before developing book-specific indicators for research evaluation purposes, especially in the social sciences. In the present study, proceeding from the results of our earlier study we focus on the following questions.

- What are the characteristics and differences of citation distribution between books and journal articles in the natural, applied and social sciences?
- Do citation processes reflect different ageing of information published in books and periodicals?
- Can advanced bibliometric tools designed and developed for journal literature be applied to books as well?

Methodology
The complete 2005 volume of the WoS including the three journal databases Science Citation Index Expanded (SCIE), Social Sciences Citation Index (SSCI) and Arts & Humanities Citation Index (A&HCI) as well as the Book Citation Index (BKCI) has been processed as source documents. The overlap with proceedings and journals were removed and only so-called citable document types have been taken into account. In this study, two periods of citation window, three years as short term and nine year as long term, are applied for a cited-life comparison.
Items extracted from the WoS have been assigned to the 74 individual subfields according to the modified Leuven-Budapest classification system. Three major fields in this scheme representing natural sciences, applied sciences and social sciences, which are Chemistry (205 books and 192,153 journal articles), Engineering (481 books and 32,000 journal articles), Social Science I (214 books and 120,841 journal articles), respectively, are selected in this study to identify the distinct characteristics of publications in different fields. The first model used for the analysis of the citation patterns to answer the first research question is the distribution of citation received in a given period over individual documents. The second model for the second research question derived from the change of citations over time is the life-time curve and, more sophisticatedly, the use of stopping-times. The third model answering the third research question used a parameter-free solution, Characteristic Scores and Scales (CSS) introduced by Glänzel and Schubert in 1988, to analyse the citation distribution of papers over some essential performance classes.

Results

The first results refer to citation distributions and ageing of information. The strong polarisation of book citations already two years after publication – but even stronger six years later – is striking in all selected fields. The life-time analysis reveals similar characteristics. On the one hand, the ‘maturing’ and ‘decline’ process of books seems in general to somewhat slower than that of articles and their impact seems consequently to last also longer. However, this applies to the natural and applied science. In the field of the social sciences the life-time curves almost coincide. The stopping-time approach reveals some additional aspects and somewhat differentiates the obtained picture.

The second part refers to Characteristic Scores and Scales. As expected, the scores considerably vary among fields and according to the length of citation window. Publications in the chemistry are much higher citation numbers than those in other fields. Books in chemistry field have less poorly cited items than other fields. Furthermore, the different threshold values for book and journal literature meet the expectations since journal literature is broken down by articles. The robustness of the distribution of items over classes is quite striking and in line with the expectations on the basis of journal literature.
Discussion and implications

Some characteristics of citation distributions could be identified since they apply to all selected fields: the strong polarisation of book citations and their high shares of frequently cited items. Some boundaries of similarity between sciences and social sciences are revealed in the life-time analysis. The maturing and decline process of citations to books in the natural and applied science is slower than that of articles. Consequently, their impact lasts longer. This is in contrast to the coincident curves in the social sciences. To further, the life-time of articles in the social sciences is longer than that of articles in the sciences. The Chemistry and Engineering sciences also have similar patterns of stopping-time for both document types during the first nine years.

Additionally, we can delineate some distinct characteristics of fields. In chemistry, the impact of publications is much higher than other fields. Books in chemistry have a higher share of uncited books but lower CSS-class share of poorly cited items than journal articles. It shows the higher impact of cited books than journals in chemistry. Expectedly, their characteristic scores are the mostly higher than journal articles compared to other fields. They also have longer citation life than journal articles. In the social sciences, books and journal articles have correspondent life-time curves and more similar stopping-time patterns compared to other fields. Unlike those in other two fields, journal articles in the social sciences have longer citation life since they are cited more frequently with a citation period longer than five years. Their uncited rate is higher than books, but they have higher CSS-class share of highly cited items after six years. In accordance with the longer life time of journals in the social sciences, their share of highly cited articles increases when time elapses, while those of journals in other fields decrease conversely.

To sum up, the different characteristics across two document types are listed as follows. Books have a stronger polarisation of citation distributions and higher impact, especially in chemistry. The life-time of citations to books is slower than that of journal articles in the sciences, but not in the social sciences. Similarly, the shares of highly cited items of journal articles decrease in the sciences when time elapses, but increase in the social sciences. Finally we have seen that advanced models and indicators which have been developed for periodicals also work for books – however with
some limitations. CSS classes and stopping-time based indicators proved robust enough to be applied to books as well.
Firms’ collaboration with domestic and foreign universities: what can co-authorship data tell us?
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Session on Technology transfer and cooperation between academia and industry
Wednesday 2nd of September, 11:00 – 12:30, room 355.

This paper has two aims. First, to map the development of Norwegian private firms’ scientific co-authorship over the last 20 years. Second, to use knowledge of central events in the Norwegian research system to reflect upon the patterns seen in the data.

The basic question we want to explore is whether we see signs of a mismatch between the knowledge needs of Norwegian industry and the profile of the domestic public research organisations. We ask the following specific research questions: Do Norwegian firms collaborate more over time with foreign universities, and does this come at the expense of national collaboration? Has the pattern of domestic collaboration changed with respect to the types of organisations that firms publish with?

Our analysis is based on data retrieved from a bibliometric database produced by Thomson Scientific as the National Citation Report (NCR) for Norway for the years 1991 to 2010. After a thorough procedure where sectors and countries are identified in the data, the co-authorship information has been further analysed using social network analysis (SNA). The basis for the quantitative part of this paper is a set of scientific publications from 1991 to 2010 with at least one address representing a Norwegian firm, totalling around 8000 publications. The share of industry
papers has decreased in the time period, mainly due to a strong increase in academic publishing.

There are significantly more firms involved in publishing academic texts, from 70 in 1991 to 238 in 2010. As such scientific publishing has become more common among firms, strengthening the value of this indicator. Over time, co-authorship with Norwegian universities is fairly stable (around 50 per cent of the industry papers), while co-authorship with the applied research institutes has become less common. The share that is co-published with other Norwegian research organizations (mainly non-university hospitals and regional colleges) has almost doubled, as has the share co-published with foreign universities in an ever increasing set of countries. In other words, the descriptive data show an expansion where it seems that both local and international ties are increasing, mostly at the expense of linkages to the applied research institutes.

Using the SNA methodology and dividing the data into four 5-year periods, we show that Norwegian universities have become much more central nodes in the industrial publishing network, while the research institutes have become less important but remain central nodes as well. Although a fairly large share (around 20 percent) of the publications are co-authored with other Norwegian research organisations, these are not central nodes in the network. Over time, more foreign universities are added, and some countries’ universities move closer to the centre of the networks. The most used foreign university partners are found in the US, UK and Sweden.

We find clear evidence of an increased internationalisation of Norwegian firms’ involvement in knowledge production in the form of scientific papers. This takes several forms: increased volume and share of internationally co-authored papers and increased geographical scope although the main partner countries remain the same. However, we do not find conclusive evidence that this is due to a general mismatch. On the contrary, Norwegian universities seem to become more important partners to Norwegian firms even in this general pattern of internationalisation. This seems to happen at the expense of the applied research institute sector, which is no longer industry's main partner in publication. If there is a mismatch, the challenge seems to be with the research institutes rather than the higher education institutions.
This raises a number of interesting issues. First, what is behind the relative decline of the Norwegian applied institute sector? Although this may be tied to the type of data or changes in incentive structures for universities, it may also signify a more fundamental shift in the public R&D system in Norway. Second, what is the role of the domestic higher education institutions in this picture of expanding internationalisation? It seems like the Norwegian universities in particular may be central in firms’ expansion of their research networks. Third, there may be a two-sided picture of mismatch here. Policymakers tend to focus on how national research and higher education needs to be tailored to the needs of domestic firms (and other organizations), and mismatch then occurs when firms are unable to find national partners in research collaboration. But with increasing scientific ambitions among universities, national firms may not always be good partners for the universities. This could also explain why the more local colleges and hospitals have increased their visibility as partners in industrial co-authorships in our data.

Our analysis may have implications for policies particularly concerning the division of labour in the research system. This seems to be less stable than what one might assume from the long-term nature of research work. Even in a country with long traditions for industry-specific applied research institutes such as Norway, universities (both foreign and abroad) seem increasingly to be preferred partners and gatekeepers for firms. This development deserves further in-depth study, also looking at the effects of very recent mergers between higher education institutions and research institutes.
Gender equality in higher education institutions in Europe. An analysis based on ETER data

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Session on Characterizing higher education institutions
Friday 4th of September, 10:30 – 12:15, auditorium.

Abstract

The aim of this paper is to present data on gender equality throughout European Higher Education Institutions (HEIs), primarily based on data from the ETER (European Tertiary Education Register) database. The intention of the paper is to describe differences in gender composition of academic staff and full professors in different countries. However, as there are limitations to the explanations that can be derived from statistics collected in one single year, we will also look at a single country, Norway, to explore historical developments. In order to do this, we use a supplementary data source.

ETER, the main data source used in the paper, is a database aimed at collecting comparable data for European higher education institutions (HEIs). The database cover data on number of students, graduates and staff, as well as information on expenditures and different descriptors of the institution (such as institution type, size or foundation year). Hence, the database can be used to explore a range of issues, but in this analysis, we focus on staff and the breakdown by gender.

The patterns of gender inequality in academia have proven to be remarkably stable over time, and they exist across countries. This is particularly visible if we look at the share of women among full professors. While the share of females are equal to the share of men among students in most countries, and there is a rise of number of women among PhD-graduates, there still no gender balance in sight among professors. Figure 1 show share of females among full professors in European countries.
Figure 1 Gender equality among full professors/grade A personnel in selected European countries.

Source: ETER (2011/2012) and She Figures (2009)

In general is the share of women among professors low in most countries, less than 30 percent. No country report over 40 percent female professors on average, however some individual HEIs have high share of female professors. The share of females among academic staff is considerable higher, tough not gender equality in most countries. Latvia and Lithuania are the only two countries that have more females than males among the academic staff. However, it does not look as if this transfers immediately to the highest position in academia, professorship. Latvia and Lithuania does not have a higher share of female professors than most other countries. However, this may have historical roots.

In order to describe the historical development of gender equality among different groups in academia we will take a closer look at Norway. Using data from the Norwegian Register of Research Personnel, we will explore changes over time in the gender composition of different position in academia in Norway. We will also investigate if there are differences in gender composition between different types of institutions, comparing the
share of women among PhD-graduates, associate professors and full professors. Analyses of data from the late 70’s and until today indicate a steady rise in share of women at all levels, particularly since the early 1990’s. However, the share of women among professors have not risen as much as the share of women among PhD-graduates and associate professors. Today, every second PhD-graduate are female, and females constitute 40 percent of associate professors. However, the share of females among full professors are still only at 25 percent.

In conclusion, have the analyses in this paper shown that many European HEIs are approaching gender equality among academic staff, but that there still is a way to go to reach gender equality among full professors in academia. However, several of the countries that have a relatively high share of female professors (above 30 percent) are also among the countries that have high shares of women among academic staff in general. This indicates that time may help increase gender equality in HEIs in Europe.
The multi-layered and multilevel use of bibliometric measures in Swedish universities: Isomorphism, translation and strategic choice

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Session on Performance measurement in higher education and rankings
Thursday 3rd of September, 16:00 – 18:00, room 355.

In recent years, systems for resource allocation in academic research based on performance indicators have been introduced in many European countries (Hicks, 2012). Today, we are at a point where the use of bibliometrics based indicators for research evaluation and resource allocation more or less permeates academic systems on all levels and across the world. The implementation—and the effects of the use—of bibliometric indicators on the micro- and macro-levels have been studied, but the exploration of the use of bibliometric indicators for resource allocation in academic research on the meso-level—that is within HEIs, between faculties and departments—has so far been limited, albeit with some exceptions (Aagaard 2015; Hammarfelt & de Rijcke 2015).

This study provides a comprehensive overview and analysis of the local use of bibliometric indicators at Swedish universities through a survey directed at 26 Swedish institutions of higher education and our theoretical focus is inspired by new institutionalism theories (DiMaggio & Powell, 1983).

Findings

Bibliometric measurement is currently applied in 24 of the 26 HEIs in our study. There is large variation in terms of what kind of bibliometric indicator being used for resource allocation. Generally, we can identify

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1 This work was supported by Svea Bredal Foundation, and the Swedish Foundation for Humanities and Social Sciences (SGO14-1153:1).
three main types of indicators: those counting number of publications, those based on citation frequency, and those making calculations based on a combination of citation and publication counts (Table 1).

As with the choice of publication or citation based indicators, we find a wide variation in terms of on which levels bibliometric indicators are used for distributing resources at different HEIs. Seven out of the 26 HEIs in our sample are use bibliometric indicators to allocate resources directly to individuals. The models used at Blekinge Institute of Technology and Luleå University of Technology are perhaps the most straightforward ones as they directly allocate resources—in the form of research time or travel money—based on articles published in journals indexed in Web of Science or rated at prestige level two in the Norwegian system.

**Discussion**

Performance based allocation based on bibliometric indicators has become the norm in Swedish academia. From a viewpoint of ‘new institutionalism’ we could describe the current focus on bibliometric measurement at Swedish HEIs as a result of isomorphism. Still, even if many allocation models resemble each other we find that a range of different indicators is used on various levels.

Table 1. Type of indicator and type of organization.

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<td>BTH: Blekinge Institute of Technology, CTH: Chalmers University of Technology, GU: University of Gothenburg, GIH: The Swedish School of Sport and Health Sciences, HB: University of Borås, HH: Halmstad University, HHS: Stockholm School of Economics, HiG: University of Gävle, HJ: Jönköping University, HS: University of Skövde, KAU: Karlstad University, KI: Karolinska Institutet, KTH: Royal Institute of Technology, LiU: Linköping University, LNU: Linneaus University, LU: Lund University, LTU: Luleå University of Technology, MAH: Malmö University, MDH: Mälardalen University, MIU: Mid Sweden University, SH: Södertörn University, SLU: Swedish University of Agricultural Sciences, SU: Stockholm University, UmU: Umeå University, UU: Uppsala University, ÖU: Örebro University.</td>
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2 BTH: Blekinge Institute of Technology, CTH: Chalmers University of Technology, GU: University of Gothenburg, GIH: The Swedish School of Sport and Health Sciences, HB: University of Borås, HH: Halmstad University, HHS: Stockholm School of Economics, HiG: University of Gävle, HJ: Jönköping University, HS: University of Skövde, KAU: Karlstad University, KI: Karolinska Institutet, KTH: Royal Institute of Technology, LiU: Linköping University, LNU: Linneaus University, LU: Lund University, LTU: Luleå University of Technology, MAH: Malmö University, MDH: Mälardalen University, MIU: Mid Sweden University, SH: Södertörn University, SLU: Swedish University of Agricultural Sciences, SU: Stockholm University, UmU: Umeå University, UU: Uppsala University, ÖU: Örebro University.
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<th>Type of organization</th>
<th>Type of indicator</th>
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<td>Publication based</td>
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<td>University</td>
<td>SU*, LNU</td>
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<tr>
<td>Specialized university/college</td>
<td>LTU, BTH</td>
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<tr>
<td>University College</td>
<td>MIU, MDH, SH, HB, HiG, HH, HS</td>
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*Not used throughout HEI, only at certain faculties/departments.

**Privately owned institutions managed in collaboration with the Swedish government

Hence, it is evident that national systems are translated, negotiated and possible also contested on the local level. We also see clear evidence for strategic choices being made when indicators and systems are chosen. Finally we argue that in-depth and systematic knowledge about the actual use of bibliometrics across all levels of academia is pre-requisite for studying the effect of measurement. Further studies might, help us to understand how indicators on all levels, from university rankings to evaluation of individual researchers, reinforce, interact and contradict each other in the forming of a ‘metric’ culture in academia.

References


Institutional Context and Growth of New Research Fields. Comparison between State Universities in Germany and the United States

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Session on The dynamics of research fields
Thursday 3rd of September, 10:45 – 12:30, room 355.

The paper examines the capabilities of universities to rapidly build up and expand research capacities in new and emerging scientific fields following major scientific breakthroughs. Based on the Scanning Tunneling Microscope (STM), developed in 1982 (Nobel Prize in Physics, 1986), and Buckminsterfullerenes (BUF), discovered in 1985 (Nobel Prize in Chemistry, 1995), the paper investigates how fast scientists in German and US state universities built up follow-up research in response to these two breakthroughs. Most importantly, the paper explores to what extent the institutional framework in which universities are embedded supported such expansion and renewal.

Methods and Data

The methodical basis of the study is the construction of a strictly comparable set of state universities. The paper analyses longitudinal quantitative data of 84 German and 155 US state universities that award doctoral degrees. In addition, the paper provides case study evidence for state universities in Bavaria and California, two states in which both STM and BUF follow-up research has been particularly strong.

Results

Our bibliometric findings (dependent variable) demonstrate that scientists in US state universities were several years ahead of their colleagues at German

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3 This work was supported by grant 01UZ1001 (BMBF).
universities in seizing on STM and BUF. Our institutional findings (explanatory variables) suggest that in the years following STM and BUF, i.e. the 1980s and 1990s, US universities provided better institutional conditions for scientific renewal than German universities.

First, a high percentage of professors among scientific staff is conducive to building up and expanding research capacities in new and emerging fields. Two mechanisms are involved: A high percentage of professors raises the frequency by which new research opportunities are both detected and followed up by those who are expected to conduct independent research; in addition, a high percentage of professors raises the frequency by which new peers are hired, and new research topics and areas thus are imported in replacement of previous ones. A low percentage of professors, as in Germany, indicates that many more young scientists work in the academic system than can be possibly absorbed into professorial ranks. As a consequence, there is a bottleneck at the transition to professorial status, leading to prolonged periods of dependency and job insecurity in academic biographies. In the US, the transition to assistant professor, and thus scientific independence, takes place earlier in the biography, thus providing favorable conditions for seizing upon new and promising scientific opportunities.

Second, growth in the number of professors, growth in basic funding, and a high percentage of grant funding among all funding streams are key factors positively associated with building up and expanding research capacities in new and emerging fields. In fact, a declining or stagnating number of professors severely constrains the capability of universities and their departments to respond swiftly to new and emerging research fields by recruiting outstanding scientists, as demonstrated in our German case studies. Furthermore, if growth of basic funding is channeled into facilities and laboratories that are shared by professors both inside and across departments, supportive conditions for effective collaborations in new and emerging fields are created. Yet, too strong dependency of professors on grant funding and too high competitive pressure for external research resources may inadvertently end successful scientific collaborations before all fruits are harvested.
Third, our findings point to significant and increasing differences in the state university systems of Germany and the US with major implications for innovations in science. Although the percentage of professors decreased in both countries since the 1980s, this decrease took place at different scales. Furthermore, inflation adjusted basic funding for US state universities has grown by factor 2.0 since the 1980s with tuition fees providing the lion’s share in growth; in contrast, basic funding for state universities in Germany has grown by factor 1.5 only. Tuition fees, which had been introduced in the mid 2000s in some German Länder states, were abolished recently, thus reducing the level of basic funding in German universities. Based on our empirical findings, the conditions for scientific innovations in German universities are worse today than they were in the 1980s and 1990s, in contrast to the US.

Discussion and implications

The results have implications for research policy in Germany and the US. For Germany, the study identifies as major policy problem the scientific staff structure which appears to severely impede intellectual renewal and growth of new research fields. Recent government funding initiatives such as the DFG excellence funding did not target the extremely low percentage of professors and are thus unlikely to improve reception speed. For the US, the rising percentage of “contingent faculty” might compromise the strong position of US state universities in the future.

References


Cambridge University Press.
Measuring and reporting R&D and innovation costs in multi-unit service firms: a new approach

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Session on Innovation and emerging technologies
Thursday 3rd of September, 09:00 – 10:30, room 355.

Innovation indicators, gathered through instruments such as the Community Innovation Survey (CIS) are used by policymakers and others to assess the innovativeness of a country’s industries and sectors. Firms are increasingly interested in these measurements because they are used in the management of innovation and in various forms of external communication and highly visible indexes such as the Dow Jones Sustainability Index. These instruments have been criticised, not least because they seem to fit better to manufacturing firms than service firms. The purpose of this paper is to analyse the results of an attempt to create a new approach to gathering data on innovation expenditures that is particularly tailored to service firms. This approach has been tested three years in a row in Telenor, one of the world’s largest telecom companies headquartered in Norway. Our research questions have been: What are the central features of a measurement system of R&D and innovation expenditures that take the particularities of service firms into account, and what are the practical challenges in gathering reliable and transparent data?

Earlier research has shown that R&D and innovation cost measurement poses particularly difficult challenges to large service firms (Hipp and Grupp 2004). One reason is that service innovations are often created as an integrated part of service delivery. Innovation expenditures are for this reason difficult to isolate from regular operative expenditures. Moreover, new services are seldom created in centralized R&D units, but close to customers in multiple local markets. This complicates the process of acquiring internal innovation cost data. Finally, service innovation is to a
large extent about investments in service delivery platforms and new business models, which are not easily captured by established innovation cost indicators (Shapiro 2007). Service sectors in general are problematic in measurement due to the strong interactive nature (user-producer etc.) of the innovation process and the complex interrelationship between technological and organisational infrastructures and various forms of new business models and service delivery approaches.

We address these practical challenges from the perspective of a large telecom service firm. Based on experiences from measuring innovation expenditures, we present a tool that other service firms can use as a baseline for measuring and reporting their innovation activity, and we discuss the policy implications arising from our significantly different results compared to the orthodox approach. In particular we highlight the challenges with this approach to measuring innovation expenditures.

Telenor Group is the incumbent telecommunications company in Norway, with headquarters located at Fornebu, close to Oslo. Today, Telenor Group is mostly an international wireless carrier with operations in Scandinavia, Eastern Europe and Asia, working predominantly under the Telenor brand. Its around 200 million subscribers make it one of the largest mobile phone operators in the world with 13 business units defined geographically.

Taking the service innovation literature into account, we chose to distinguish between three main categories of R&D spending in Telenor: R&D spending on new infrastructure, R&D spending on new services and R&D spending on new business models. In order to isolate an R&D component (from non-R&D) in the infrastructure projects, we further distinguished three categories of expenditure: (a) expenditure on the maintenance of existing networks and platforms, (b) expenditures on significant upgrading existing networks and platforms and (c) investments in brand new networks and platforms. In accordance with existing definitions of R&D, we chose to count only (parts of) the last two categories as R&D expenditure. The relevant R&D and innovation share of each infrastructure project was calculated in a detailed procedure. We decided to include both operating expenses and capital costs in the estimates because the acquisition and subsequent interlinking of capital equipment such as
satellite base-stations, routers, switches, cabling systems and specialized software forms an integral part of Telenor experimental activity.

We used a variety of data sources including financial reports, internal R&D reports and interviews with key managers and financial controllers. In addition, the project group developed and distributed a specialized survey asking for innovation and R&D data from Telenor’s R&D performing business units. Finally, the group interviewed key managers in Telenor’s corporate finance unit as well as R&D project coordinators. The project group manned a helpline and made sure that all reported expenditures, down to single project level, were checked by controllers and R&D managers. This exercise was first carried out in 2012 and has been repeated twice.

The results for show that this methodology leads to a measure of R&D costs that is 5-10 times higher than the company’s traditional estimates. This large increase was not dominated by the infrastructure component. A little less than 10 per cent of the infrastructure project costs (brand new and significant improvements) were defined as innovative. This figure was slightly lower than innovation expenditure related to developing new services and quite similar to expenditure related to business models. The methodology highlighted the importance of company-internal but still decentralised innovation activities in the various business units. Market launch of new services and business models turned out to be a significant share (more than half) of the costs. Many of these activities did not take place in Norway. Third and to the surprise of the company itself, the innovation expenditure of the close-to-market business units outside of Norway was almost twice that of the Norwegian mother company which includes the central R&D unit and the technology development unit.

A central challenge is the large annual fluctuations in R&D and innovation expenditure within each specific expenditure type. Especially for infrastructure projects costs are very different from one year to the next, which is related to challenges of how large-scale investments are handled from a financial and bookkeeping point of view. Another clear challenge was the lack of internal (inside Telenor) consensus about R&D and innovation, between and within business units and professional groups. There is a discrepancy between Telenor’s internal technology accounting policy and information requirements associated with broader innovation
measurements. We discovered that the CIS reporting was dominated by which data was available from the financial/accounting division, and the consequence was that little other expenditure was included apart from salaries to personnel that had R&D as a full-time task.
Research Data Explored II: the Anatomy and Reception of figshare\textsuperscript{4}

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Session on Advanced topics in research data  
Friday 4th of September, 10:30 – 12:15, room 355.

We are currently witnessing a change in scholarly communication. Next to the paper, complementary materials, such as research data, source code, and images are regarded as important outcomes that should be shared and built upon. In this new ecosystem, many archives have been established that cater to the needs of a digital and open science. With the increasing importance of research data in the last years, these archives are now receiving initial interest from bibliometrics research.

\textsuperscript{4} The Know-Center is funded within the Austrian COMET program – Competence Centers for Excellent Technologies - under the auspices of the Austrian Federal Ministry of Transport, Innovation and Technology, the Austrian Federal Ministry of Economy, Family and Youth, and the State of Styria. COMET is managed by the Austrian Research Promotion Agency FFG.
In an earlier study of the Data Citation Index (Peters et al., 2015), we found that while research data remain mostly uncited (about 85%), there has been a growing trend in citing data sets published since 2008. One of the more surprising results of our first study was that none of the items from figshare (http://figshare.com), which is one of the largest multidisciplinary repositories for research materials to date, has received more than one citation in the DCI.

In this paper, we investigate figshare more deeply. For this purpose, we analysed the structure of items archived in figshare, their usage, and their reception in two altmetrics sources with a focus on datasets and filesets. Three different data sources were used in this study: (i) figshare, (ii) PlumX and (iii) ImpactStory.

We used the figshare API to retrieve the basic metadata for all publicly available records up until (excluding) December 2, 2014 (n=1,092,808 items). We then gathered extended metadata for all datasets and filesets with a unique DOI (n=266,961 items). Both datasets are openly available (see Kraker et al., 2015). Subsequently, the top 500 downloaded items and the top 500 viewed items were analysed with PlumX and ImpactStory via their DOIs. Their coverage on social media platforms and the altmetric scores were compared.

In our study, we found that almost 90% of all entries in figshare are coming from PLOS. figshare therefore has three basic functions: it acts (1) as a personal repository for yet unpublished materials, (2) as a platform for newly published research materials, and (3) as an archive for PLOS. These different functions are also highlighted by the fact that unviewed and non-downloaded items tend to originate from PLOS. These items are mainly used on the PLOS site, and not on figshare.

It is important to consider the different functions when interpreting the results of a figshare analysis. When analysing the discipline distributions of datasets and filesets, one could easily assume that most users who share their data are from the Natural Sciences (88.9% of all items are assigned to Biological Sciences, Chemistry comes second and Earth Sciences third). More in-depth analysis, however, reveals that the majority of Natural Sciences content is coming from PLOS, and that there seems to be a larger user group sharing datasets coming from Engineering and Social Science.
Another unexpected result was that the most shared type of research material is not data, but rather images.

In the altmetrics analysis, we found that Twitter was the social media service where research data gained most attention; generally, research data published in 2014 were most popular across social media services. PlumX detects considerably more items in social media and also finds higher altmetric scores than ImpactStory.

Compared to our previous analysis performed for research data with two or more citations in Data Citation Index (DCI), the following conclusions can be drawn:

Most research data remain not only uncited but also unviewed/not downloaded.

Corresponding altmetrics scores for most cited, downloaded and viewed research data are very low, but overall the numbers have been increasing within the last 3 years.

The results of the comparison of PlumX and ImpactStory are very similar to those obtained in our previous study. In general, comparison of altmetrics tools is difficult due to differences in assignments to categories, which result in different counts. Furthermore, it is hard to judge correctness and completeness of the counts.

References


The dynamics of university institutes as a multi-level process. Credibility cycles and resource dependencies

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**University of Fribourg, Switzerland, Departement Medien- und Kommunikationswissenschaft

Session on Funding and its impacts on research groups and individuals
Wednesday 2nd of September, 13.45 – 15.15, room 355.

The goal of this paper is to investigate the association between the acquisition of resources and the development of profile of research institutes within universities. The relevance of this topic is heightened by funding reforms, characterized by increasing competition and selectivity, as well as by the attempts of the State to steer research through resource allocation, what has been labeled as “academic capitalism” (Slaughter and Leslie 1997). In this new regime, research units are embedded in a market system, where they compete for resource from relevant customers, which buy research services based on their specific needs.

The paper builds on previous work dealing with research institutes (Crow and Bozeman 1998) around the notion of laboratory profiles (Larédo and Mustar 2000, Braam and Van den Besselaar 2010) and, specifically, on the interaction between profiles and resource acquisition through distinct credibility cycles (Latour and Woolgar 1979) and association with specific audiences (Joly and Mangematin 1996).

We specify this approach for the case of university units considering that the departmental level controls a critical resource for the unit’s activities, namely the professor positions (Coronini and Mangematin 1999). Further, departments largely control the educational offer where units are involved, and therefore, their competition for external students (and the related resources). Finally, in most European countries, the largest part of research funds is also distributed through the university, while third-party funds
acquired directly by units are complementary, even if their share has increased in the last decades (Lepori, Dinges, Reale, Slipersaeter, Theves and Van den Besselaar 2007; Jongbloed and Lepori 2015).

The main goal of this paper is therefore to develop and test empirically a model of the interaction between institutional characteristics of resource allocation and the development of research units. We particularly focus on the implications of dual funding and of the interaction between institutional funding and third-party funds for the development of university research institutes.

To this aim, we conceptualize resource acquisition as a two-level nested process, where units compete for external resources based on their credibility, but at the same time compete for professor positions within the larger units (department) to whom they belong. This second game might follow different rules depending on the university the units belongs to, as well on the broader national policy environment of higher education.

We test the model on a sample of 18 university units in the field of Communication sciences within different Swiss universities. The units share the general characteristics of the field, but differ in the specific subject domains, as well as in their institutional embeddedness. We hold quantitative data on resources, activities and outputs of these units for a five-year period, which is integrated with qualitative information on university and unit’s strategies, as well as on the overall development of the field (Probst, Lepori, De Filippo and Ingenhoff 2011). This allows testing quantitatively hypotheses concerning the association between resources and activity profiles, which are then complemented with more descriptive information in order to interpret the observed patterns.

The relevance of this work is threefold. First, we provide and test empirically a realistic model of the development of university research institutes, which takes into account their double embeddedness and resource dependency. Second, by this model, we are also able to conceptualize the impact of strategic choices at the university and departmental level on units’ development and the interaction of such choices with external resources (depending also on the units’ characteristics and level of credibility). Third, more in general, we advance the understanding of the impact of institutional
configurations of funding systems on the development of research at the units level.

References


Differentiation and Layering in Higher Education. A Typology of European Research University.

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Session on Characterizing higher education institutions
Friday 4th of September, 10:30 - 12:15, auditorium.

The main aim of this paper is to provide an innovative more nuanced analysis of the diversity of the European Higher Education Institutions (HEIs) testing empirically whether it is possible to distinguish in Europe between research performing and non-research performing HEIs and whether, among the latter, a group of research-intensive universities can be identified, similarly to the ones in the Carnegie classification. The main reason that lead us to conduct this research is the lack in the current literature of empirical evidences in terms of differentiation and layering in European higher education. In fact, the few studies developed on a larger sample of European HEIs point out a complex picture of diversity across different dimensions (Daraio, Bonaccorsi, Geuna, Lepori, & et. al., 2011) but fail to come to general conclusions concerning the structure of the European higher education system (Schubert et al., 2014).

Research Methodology
The database studied in this research refers to the European Tertiary Education Register (ETER). It includes 2,293 HEIs in 31 European countries constituting the whole population of HEIs in the considered countries. The dataset has been matched with the SCIMAGO institutional ranking for the year 2007-2011 as well as with EUPRO database so as to collect the number of participations in European Framework Programmes (EU-FPs) from 2008 to 2013 (Roediger-Schluga & Barber, 2008). A step-by-step methodology is developed in order to accomplish our research

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goals. First of all, we have identified different groups of HEIs according to conceptual considerations on their relevant dimensions like size, resources acquisition, education and research orientation. Then, the groups identified have been studied in terms of their heterogeneity and compared and discussed based on the available research and educational indicators. Instead, as second step, we have run a non-hierarchical cluster analysis, based on k-means algorithms, exclusively on a sub-sample of research performance HEIs in order to obtain a rigorous statistical classification of the latter. We have supposed “a priori” four cluster according to the first classification based on conceptual considerations. Finally, the high value of the Euclidian distance between clusters confirms the heterogeneity of the groups drawn.

**Main Findings**

Our research shows a clear distinction between non-research performing and research performing universities identifying 9 different groups of HEIs. Table 1 provides a description of the main characteristics of each group of institutions.

To sum up, the non-research performing HEIs are more heterogeneous than the research-performing group. They are generally specialised or focused in a few domains, very bachelor education oriented with a much larger teaching load without a sizeable volume of research. On the other hand, the research performing HEIs are homogeneous. They have much larger undergraduate enrolments and are mostly public and generalist. They are also classified as universities and award the doctorate. In conclusion, this research suggests an innovative promising classification (not based on well-known international rankings) of European higher institutions identifying a specific group of *top research performing institutions* not defined before and very similar to the American top-research universities classification.

*Table 1. HEIs Groups Description*

<table>
<thead>
<tr>
<th>Type</th>
<th>Group</th>
<th>Total HEIs</th>
<th>Undergr. Students (Mean)</th>
<th>Characteristics</th>
<th>Examples</th>
</tr>
</thead>
</table>

84
<table>
<thead>
<tr>
<th></th>
<th>Public Generalist</th>
<th>Research Performing</th>
<th>Non-Research Performing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Specialist</td>
<td>546 2.247</td>
<td>Mono-disciplinary. Low teaching load with a limited number of students enrolled.</td>
<td>Art or Design Schools. Music Schools. Technical and Defence Schools</td>
</tr>
<tr>
<td>Private</td>
<td>553 1.612</td>
<td>Quite specialized in single fields. Most of them are newly founded.</td>
<td>Young Private Business School and Private Distance Universities</td>
</tr>
<tr>
<td>Distance Education</td>
<td>37 16.469</td>
<td>Large number of students enrolled. Tiny amount of academic staff. Strongly focused on bachelor education.</td>
<td>Open University of Madrid and Distance University of Hagen.</td>
</tr>
<tr>
<td>Large Generalist</td>
<td>111 37.829</td>
<td>High level of publications. Significant number of EU-FPs participations. High teaching load and rather good normalized impact factor.</td>
<td>Roma La Sapienza, Complutense in Madrid and University of Vienna</td>
</tr>
<tr>
<td>Medium Generalist</td>
<td>428 14.665</td>
<td>Good level of publications with a rather good normalized impact factor. The teaching load is fairly relevant with a considerable research orientation.</td>
<td>Zurich, Coimbra, Gottingen and Leiden</td>
</tr>
</tbody>
</table>

No sizeable volume of research. Relevant teaching load. Bachelor education oriented. This group refers to the College Model.
| Top Research | 32 | 7.272 | Very high number of publications, normalized impact factor and number of participations to EU-FPs. Master education oriented and low teaching load. | Oxford, Cambridge, ETH Zurich and Karoliska |
| Specialed | 65 | 4.118 | High specialized mainly mono-disciplinary. The teaching load is low as well as the number of students enrolled. | London Business School and Medical Universities |
| Non Publishing | 110 | 9.207 | Somewhat intermediary between the generalist non-research performing and the other research-performing HEIs. Sizeable number of PhDs and some participation to EU-FPs. This group includes some colleges which were awarding the HEIs status (e.g. UK and Norway). | Private and Specialized HEIs and Non-doctorate awarding HEIs with participations to EU-FPs |

**References**


The information value of early career performance: A ROC analysis of prediction errors in bibliometricly informed decision making

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Session on Academic careers
Thursday 3rd of September, 10:45 – 12:30, auditorium.

Introduction
In this study we examined the information value of early career publication rate as a predictor of future publication rate at the individual level in the mathematical subfield of number theory. While many prediction studies have been designed with a continuous dependent variable (e.g., publication rate) and focused on questions concerning the effects of covariates and model fitting (e.g., Dubois, Rochet, & Schlenker, 2014; Haslam & Laham, 2009; Laurance, Useche, Laurance, & Bradshaw, 2013; Williamson & Cable, 2003), less attention has been given to research designs more attuned to concrete decision-making contexts where most decisions are binary (Acuna, Penner, & Orton, 2013).

In this study we deal with prediction as a binary classification problem to render our research design with a realistic touch. From a decision making perspective it is important to gain knowledge, not only of the degree of continuity between past and future research performance as measured by bibliometric indicators, but also the potential costs of prediction errors and how different cut-off values for the classifiers effect the outcome (Peterson, 2009). The purpose of this study was to provide an analytical framework and gain knowledge of the information value of early career publication rate as a predictor for future publication rate performance from the point of view of decision making in academia and the prediction errors in binary prediction contexts.

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5 This work was supported by The Swedish Research Council.
Method

Data

Our data consisted of the article track records of 508 mathematicians active between 1985 and 2008 in the mathematical subfield of number theory. The bibliographic data was downloaded from the comprehensive mathematical database MathSciNet.

Univariate ROC analysis

In this study the publication rate during the first five years (p1) was used as a classifier to determine whether the mathematicians did or did not belong to a specific publication rate based top performance group between the sixth and the eleventh year (p2) of the publication career. We compared three different definitions of a top performance group, top 50%, top 25%, and top 10%. The threshold for the top 50% group in p2 (i.e., between year six and 11) was the 50th percentile, the threshold for the top 25% group in p2 was the 75th percentile, and the threshold for top 10% group was the 90th percentile. The publication output of the 508 mathematicians in p2 was used as a reference set to calculate the percentiles.

We performed a univariate ROC analysis to examine how the definitions of a top performance group affect the prediction errors. We used a ROC graph to represent the trade-off between the proportion of mathematicians that was correctly classified as positive (true positive rate) and the proportion mathematicians that where falsely classified as positive (true negative rate) as the classification cut-off threshold varies over all possible cut-offs (Figure 1) (Fawcett, 2006). The positive diagonal is defined as the reference line. If the values of the test variable are above the reference line it performs better than expected according to a random model (Fawcett, 2006).

Multiple logistic regression analysis

We fitted three multiple logistic regression models and performed a ROC analysis on the basis of the estimated probabilities from the logistic regression models to examine how early career collaboration and publication strategies where high prestige journals are prioritized affect
prediction errors. One model was fitted for each top performance group (Table 1). The early career publication channel prestige covariate consisted of the share of articles published in journals indexed in the MSN reference journal list (Borjas & Doran, 2012; American Mathematical Society, 2015) during p1 (coded as ShareCoreJour). The early career collaboration covariate consists of the average number of co-authorships per publication during p1 (coded as AvgCoAu). The main predictor consisted of the number of journal articles in p1 (coded as NrPubl).

**Results**

Figure 1 displays three ROC curves. We calculated the Area Under the Curve (AUC) to compare the discrimination capacity of early career publication rate as a predictor for membership in a top performance group in p2 (Table 1). The indicator of early career publication rate performs best when it is used to predict who will belong to the top 10% group, indicating that performance over time is more stable among the extreme group. We used the Youden index (YI) to determine an optimal cut-off. The optimal cut-off value on the test variable is defined as a value that classifies the most number of authors correctly and the least number authors incorrectly given that true positives and false positives are equally weighted (Perkins & Schisterman, 2006). If we were to use early career publication rate as a selection criteria to prioritize the top 50% group the benefit compared to the top 10% and top 25% groups would be a higher true positive rate. The cost, on the other hand, for such a prioritization would be nearly twice as many false positives (i.e., researchers classified as belonging to a top performance group when they actually do not belong to the top performance segment) (Figure 1, Table 1).

*Figure 1. ROC graph representing the trade-off between the true positive rate and false positive rate. The circles denote the optimal cut-off in terms the Yoden index.*
According to the multiple logistic regression analysis the main predictor NrPubl had a significant (P < 0.05) positive effect on the log odds in all three models. The covariate ShareCoreJour had a significant (P < 0.05) negative effect in all three models. This result indicates that a publication strategy where high prestige journals are prioritized early in the career entail a disadvantage later in the career in terms of publication rate competitiveness. To avoid such implications of using publication rate based indicators to inform decisions in academia it may be reasonable to control for the dimension of journal prestige. However, to which degree this result apply to other fields needs validation. Collaboration (AvgCoAu) did not have a significant (P > 0.05) effect in any of the models.
Table 1. Metrics that define classification accuracy and optimal cut-offs for the univariate ROC model and multiple ROC model.

<table>
<thead>
<tr>
<th></th>
<th>Top 50%</th>
<th>Top 25%</th>
<th>Top 10%</th>
</tr>
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<tbody>
<tr>
<td>AUC, univariate model (NrPubl)</td>
<td>0.71</td>
<td>0.71</td>
<td>0.75</td>
</tr>
<tr>
<td>AUC, multiple model (NrPubl, ShareCoreJour)</td>
<td>0.72</td>
<td>0.73</td>
<td>0.78</td>
</tr>
<tr>
<td>YI, Optimal cut-off, univariate model</td>
<td>0.30</td>
<td>0.32</td>
<td>0.42</td>
</tr>
<tr>
<td>YI, Optimal cut-off, multiple model</td>
<td>0.33</td>
<td>0.39</td>
<td>0.50</td>
</tr>
<tr>
<td>Optimal cut-off, univariate model (FP, TP)</td>
<td>0.48, 0.78</td>
<td>0.18, 0.49</td>
<td>0.22, 0.63</td>
</tr>
<tr>
<td>Optimal cut-off, multiple model (FP, TP)</td>
<td>0.32, 0.65</td>
<td>0.16, 0.56</td>
<td>0.18, 0.68</td>
</tr>
</tbody>
</table>

A ROC analysis on the basis of a logistic regression with the main predictor NrPubl and ShareCoreJour as covariate (multiple model) was compared with the metrics from the univariate ROC analysis (see Table 1). As can be seen in Table 1 according to the AUC and YI the inclusion of the covariate ShareCoreJour increased the overall classification accuracy for all three performance groups.

References


Scientific Europe coming together?
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Session on Advanced Topics in Research Data
Friday 4th of September, 10:30 – 12:15, room 355.

Introduction
From its very outset a common science and technology policy was an integral part of the ‘European project’. The First Framework Programme for Research (FP) was launched in 1984. Cross border collaboration is required in most EU R&D initiatives.

In 2000 the FP was complemented by the ‘European Research Area’ initiative (ERA). Its aim is to achieve an internal market, in which researchers, scientific knowledge and technology circulate freely.

Strengthening the transnational research cooperation within the EU is one of the ERA objectives. To monitor cross border scientific collaborations bibliometric indicators based on co-publications have been developed. Although in the past the European Commission used these indicators to monitor the development of the EU R&D system, an analysis of the evolution of EU cross border publications is not included in the 2013 and 2014 ERA Progress Reports.

Research questions, methodology and data
It is well know that over the last decades the business of science has become more international and cross-border collaboration is on the rise especially for natural and life sciences and the basic disciplines of engineering

It is against the background of this globalisation that the realisation of the ERA takes place. Given the different degree of economic and scientific development of the countries publishing papers in journals covered by the WoS and their geographic location comparing the evolution of the overall fraction of internationally co-authored papers processed for the WoS with the fraction of intra-EU publications yields little information.
In this study the United States is used to benchmark the ERA. The US science and innovation system gradually developed over more than two centuries. The Federal Government does not use policy tools to strengthen research collaboration between the states of the Union. Moreover in this benchmarking exercise an administrative, not an economic or scientific partitioning of the country is used. The United States Census Bureau defines nine divisions grouping states and the District of Columbia by their geographic location (https://www.census.gov/geo/maps-data/maps/pdfs/reference/us_regdiv.pdf).

The WoS contains the information of the addresses mentioned in the by-line of the publications; in the US addresses the state code is one of the elements. This information is used to assign the US publications to the divisions. For each year in the period 1980-2014 the symmetrical co-publications matrix of the US divisions is calculated with on the diagonal the number of publications of each US division and on the off-diagonal entries the number of co-publications between two divisions. To quantify the collaboration strengths between the US divisions the Salton Index (SI) is calculated. For the EU based on each country intra-European co-publications the values of SI are calculated for each year. In this abstract only results for the six EU founding members (EU06) are discussed.

To compare the evolution of the collaboration strength between the US and the EU06, for each year the average, the median, the maximum and the minimum value of the SI are used.

These indicators provide an overall picture. The same analysis is carried out at the level of research fields using the OECD Revised Field of Science and Technology (FOS) Classification. In this classification WoS subject categories are mapped on the scientific fields.

Beside the total number of publications, the top 10% most cited publications are also used to compare the evolution of the collaborative strength between the USA and the EU06 overall and for different scientific fields.

**Results**

Over the whole period the average and median values of SI of the EU06 remains below those of the USA. For both geographic regions an increase can be observed. For the period after 1990 the value of the slope of the
linear fit for the USA and the EU05 is 0.0028 and 0.0022 (Pearson correlation > 0.99). A multiple linear regression analysis shows that for the period 1990-2014 the slope of both curves differ significantly at 5% level. For the 10% most cited publications similar results are obtained.

In a next step this analysis is made for the research fields. Except for chemistry for all disciplines the average and the median values of the SI of the EU06 are below these of the USA over the entire period. Only for Mathematics, for Earth and related Environmental Sciences and for Chemistry a ‘catching up’ of the EU06 is observed as the value of the slope of the linear fit is higher than for the USA.

Only for Chemistry a very different picture emerges. In the beginning of the 80’s of last century both the average and the median values of the SI for the EU06 were less than half that of the USA. Over the next three decades the growth rate of both indicators was considerably higher for the EU06 than for the USA and at the end of the period in some years the average and median values are even higher.
Assessing the effects of the German Excellence Initiative with bibliometric means based on two data sources.

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Session on Performance measurement in higher education and rankings Thursday 3rd of September, 16:00 – 18:00, auditorium.

The evaluation of science funding programs is a very challenging task, as goals and outcomes can be multifaceted as well as interdependent with external developments. They are thus not trivial to operationalize and to measure. This is especially the case for large research programs such as the German Excellence Initiative. The program started in 2006 / 2007 as a common funding program of the German federal government and state governments and is organized by the German Research Foundation (Deutsche Forschungsgemeinschaft, DFG) and the German Council of Science and Humanities (Wissenschaftsrat, WR).

Within the Excellence Initiative there are three funding lines: Graduate Schools promoting doctoral researchers, Clusters of Excellence (CoE) creating and promoting excellent research centres, and Universities’ Future Concepts advancing development on a university level. In our approach we focus on the Cluster of Excellence as the core research unit of the funding program, which should be the main funding line to produce bibliometrically measurable results, and which receive 60% of the total funding of the Excellence Initiative.

Goals and Research Questions
The main objective of the Excellence Initiative is to improve the international standing of German universities. For German science policy, this must be seen as a clear shift from an egalitarian to a competitive approach. While only universities are able to submit proposals, the funding program also aims to foster collaboration between universities and the strong non-university research organizations. We explore the
bibliometrically measureable effects and analyze to which extent the objectives of the German Excellence Initiative are achieved.

On a methodological level, we explore and compare two different data sources in order to attribute publications to the program: Selected publication lists in the renewal proposals submitted at the end of the first funding period and funding acknowledgements in the database Web of Science (WoS). Following the Initiative’s main premise and label, we operationalize the measurement of its outcome by using the bibliometric concept of highly cited publications (top 10% compared to the world baseline).

**Data Sources and Methodology**

Publications that result from the funding program are not publically and comprehensively documented.

Funding Acknowledgements generally represent the most promising approach for evaluating third-party funding, but their implementation in the database WoS only started in August 2008. It is furthermore a priori unclear how reliable a funding acknowledgement-based approach covers the CoE publications in the subsequent years. Selected publication lists in the renewal proposals are on the one hand used as data basis for developing a search strategy for CoE in grant texts. Additionally, the proposal corpus sheds light on the amount and characteristics of publications missed by the funding acknowledgements approach.

**Results**

For a sample of the proposal corpus, the specific database coverage of funding acknowledgements for the period 2009-2011 is checked by assessing the full texts of those publications with missing grant texts. 17.9% of publications do not have funding acknowledgements and thus have been assessed in full text. In 4.0% of all cases publications did originally include CoE-specific funding acknowledgements – this corresponds to 7.2% false negatives of a corpus delineated via CoE funding acknowledgements. In altogether 4.3% other funding sources are acknowledged in the full texts, but not in the database. While 51.3% of the sample of the proposal corpus have CoE-specific acknowledgements, 42.9% of publications could be linked via (at least one of) their authors to the CoE.

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Results for the German science system are calculated on the basis of publications of all German universities and the four leading non-university organizations (MPG, HGF, WGL, FHG) in WoS. The shares of highly cited publications for the pre-funding period (2003-2006) and the funding period (2008-2011) are calculated. The highly cited publications of CoE can be accounted for the larger part of the sectors’ increases, respectively. In case of the non-university research sector publications, CoE publications account for the whole difference between both periods, which must be seen as a strong collaborative effect.

Effects on the whole German science system thus have been made visible; however, these are not as massive as the public and science policy debate on the German Excellence Initiative suggest.

References


Career trajectories of PhD holders in the SSH: do early career choices matter?

Lucio Morettini, Emilia Primeri, Emanuela Reale, Antonio Zinilli

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Session on Academic careers
Thursday 3rd of September, 10:45 – 12:30, auditorium.

Obtaining a PhD has been considered for long to prepare for academic career. However, PhD has gradually come to a turning point: PhD holders are facing high level of unemployment (OECD, 2010) and more and more it represents a passport towards multiple careers underlying the need to decouple doctoral training from an academic career (Enders, 2002; Huisman et al. 2002).

However, little is known about initial career decisions of PhD holders most of studies being focused on a labor market perspectives, on alternative occupations-industry vs academia- of junior scientists (Cruz Castro, 2005) or on the impact of PhD training on career paths and employment opportunities (Mangematin, 2000). The paper focuses on variation in PhDs career paths according to a horizontal or longitudinal dimension (in or out the HE sector) and vertical dimension with the aim to let different career trajectories of PhD holders in the Social Sciences and Humanities emerge.

Our research questions are: what are career trajectories of PhD holders in the SSH? Is there a relationship between initial career start and career in the long run? Do data provide insights about alternative employment opportunities after PhD in the Social Sciences and Humanities beyond academic one?

We argue that early career steps and employment choices largely affect the PhD careers trajectories (Enders, 2002). Also, we assert that differences within SSH field are likely to emerge which mirror disciplines characteristics also if non-academic job positions are considered (Henkel, 2007; Bordieu, 1986). Finally we discuss as PhD in SSH could foster a
segmentation vs reversibility and flexibility of occupations for PhD holders (Cruz Castro, 2005).

**Design**

Dietz et al. (2000) argue as a set of skills, know and relationships, what they call “knowledge value”, impact on scientists’ professional paths, motivations and constraints. Enders (2002) underlines as although PhD degree matters, employment and outcomes in the labor market can be affected by different criteria: choices at the early stage of career, discipline and gender. According to the “entry-job hypothesis”, early employment choices are supposed to strongly impact on career opportunities and the sector of employment of PhD holders in the long run. Relevant variables at the entry job stages to be considered are the time of transition to work, unemployment periods, the sector and type of contract, income and status (Steijn et al., 2006).

Characteristics of scientific fields also matter. Bourdieu (1986, 1999) argues that different stages of scientific careers are strongly related to scientific field characteristics, and that each career is defined by “its position in the structure of the system of possible careers” so that a “typical “ career is questioned and different classes of career trajectories are more likely to be observed.

**Data description and methodology**

The analysis relies on the survey data developed by the POCARIM project funded by EUFP7, which investigates career opportunities, mobility and impact of PhD holders in the Social Sciences and Humanities (Ackers and Coey, 2014). Data refer to PhD graduates between 2000 and 2011 in thirteen European countries. The dataset collects information about 2652 PhD holders, from the graduation year to current job to the moment of the survey (2012).

One limitation of the dataset is that it does not include social origins and familiar background of PhD holders, but their personal information and familiar conditions only. Data do not cover also characteristics of doctoral training as factors affecting career and employment opportunities. Finally

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<http://www.salford.ac.uk/nmsw/research/research-projects/pocarim-home>
differences across disciplinary fields are not addressed the paper focusing on three main groups of disciplines only (Social Sciences, Humanities and Interdisciplinary).

We consider every career path as a discrete sequence of work status; we present two levels of analysis: in the first one we examine how the diversity of states within each path is related to disciplinary area, country of origin and country of the PhD, gender, presence of a partner, offspring, age, total unemployment (months). We compute the longitudinal entropy using the Shannon index (Cover, 2006) and regress it on the covariates. The entropy can be seen as a measure that reflects how many different jobs there are in a career trajectory for each PhD holder. The entropy is zero when all cases are in the same state and is maximal when the number of different jobs increases.

In a second phase, we present a multinomial conditional logit model (MCL). We consider every career path as a discrete sequence of level. Through MCL model, we can compute the transition probabilities of PHD moving across different job status. We want to estimate the probability to arrive to a position in function of the previous step and personal characteristics.

**Findings**

The analysis of academia entropy shows that doctorates with an interdisciplinary PhD tend to have a more homogenous career: this kind of PhD holders seem to have a largest range of skills that allow them to achieve niches in job markets that are precluded to the other Phd holders. On the other hand, homogeneity is correlated with a higher level of unemployment and these results suggest that continuity in job status is “paid” with largest period of unemployment.

Academia represents the main job place for many of respondents: those entering the academia as first position are likely to persevere in this sector while highest variability emerge when other sectors represent the first place of employment. An interesting result is that continuity in academia is strongest for PhD holders in Social Science area. However, academia seems to be a necessary step for all the PhD holders, in all the areas considered: independently by the beginning and the end of the career trajectory, all the doctorates will pass for academia with a strong probability.
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Developing Technology with Academics: Do Firms Benefit?

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Session on Technology transfer and cooperation between academia and industry

This paper analyzes the academic contribution to corporate technology development (period 1991-2010) by contrasting firm patents implying the involvement of academics (at Flemish universities) with patents of the same firms developed in-house. While most previous empirical studies focused on assessing the distinctiveness of academic patents vis-à-vis firm patents involving academic inventors, we adopt a ‘corporate’ perspective by examining the academic contribution to industry’s technology development. We assess whether collaborating with academics brings something distinctive to the firm in terms of nature and impact of developed technology. We distinguish between exploitation-oriented and exploration-oriented technology trajectories, whereby exploration refers to technology domains in which the firm becomes active for the first time.

Patent data were extracted from the PATSTAT database, October 2011 edition. The academically invented corporate patents involve inventors from Flemish universities: University of Leuven (KU Leuven), University of 105
Antwerp (UA), University of Hasselt (UH) and University of Brussels (VUB). Name matching was conducted between staff lists of Flemish universities and patent inventor names, appearing on granted EPO and USPTO patents with application years ranging from 1991-2010. 484 firm patents could eventually be identified as having at least one (Flemish) academic inventor and are therefore labeled as academically invented. In a next step, a control group was created, consisting of patents owned by the same firms and applied for in the same time period (n= 287,393 firm owned patents).

In terms of the nature of technology, findings reveal that academically invented firm patents rely less on prior technological art and are more inspired by scientific findings than the control group. No significant difference in overall novelty was observed: university-invented firm patents do not rely more on novel technological origins, novel scientific origins and are not more novel in recombining technology domains.

In order to analyze impact both the number of forward self-citations (signaling private value) and the number of forward citations without self-citations (signaling social value). When taking the number of forward self-citations as dependent variable, no significant difference is found. However, when splitting the sample in firm patents of small versus medium or large firms, it becomes clear that small firms do benefit from collaborating with academics when developing technology. For small firms, university-invented firm patents have significantly more forward self-citations than pure firm patents, implying that involving academics in developing technology coincides with more cumulative innovation by the firm itself. For medium or large firms, no such difference was found. Furthermore, when looking at the number of forward citations without self-citations, no significant differences were found.

Finally, when distinguishing between exploitative and exploratory (novel to the firm) technologies, we find that university-invented firm patents are significantly more exploratory than the control group. In a final analysis, we focused only on the exploratory technologies and calculated the firm’s technological growth in the newly entered fields (the number of consecutive patents in those new technology domains the five years after entry). Results show that for the overall sample there is no significant difference in
technological growth in newly entered fields between trajectories initiated with or without an academic inventor. However for small firms, entering new technology domains with an academic inventor coincides with higher technological growth in those fields five years after initial exploration. For medium and large firms the results suggest the opposite, entering new technology domains together with academics is related to less technological growth compared to the exploratory trajectories that were initiated in-house. As such, these findings suggest ‘selection’ effects for larger firms, whereby more uncertain trajectories become ‘outsourced’ to academia.
How can differences in international university rankings be explained?\footnote{This work was supported by the Norwegian Ministry of Education and Research}

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Session on Performance measurement in higher education and rankings Thursday 3rd of September, 16:00 – 18:00, auditorium.

**Background**

University rankings are typically presenting their results as league tables with more emphasis on final scores and positions, than on the clarification of why the universities are ranked as they are. Finding out the latter is often not possible because final scores are based on weighted indicators where raw data and the processing of these are not publically available. In this study we use a sample of Scandinavian universities, explaining what is causing differences between them in the two most influential university rankings: Times Higher Education (THE) and the Shanghai-ranking (ARWU). The overall aim of this paper is to provide a methodology that can be used in understanding universities’ different ranks in global university rankings.

**Methods**

Our method is to decompose the rankings, i.e. explain the relative importance of each indicator and to analyse size differences in the background data that causes these effects in the rankings. We use Nordic universities to exemplify, because we have the needed data for these institutions, to conduct the decomposition (however, the method we use can be used on any universities in the world, as long as the necessary university background information is available). As an illustration, in Figure 1 we show the importance of each indicator in ARWU in understanding University of Oslo’s position in ARWU compared to ten other universities.
Results

*University of Copenhagen* is ranked above University of Oslo in ARWU primarily due to more points on the indicators N&S (publications in Nature and Science) and PUB (number of publications in Web of Science) (Figure 1). However, the researcher productivity at both universities is the same, so that different PUB scores is a matter of university size – not productivity or quality. Part of Copenhagen’s extra points on N&S is attributed to Copenhagen in fact being a larger university, but some variation is also explained by a larger share of N&S publications per researcher. The universities ranked below University of Oslo are primarily ranked below because of Oslo’s higher score on the two indicators that are related to Nobel prizes: former students winning (ALU) and current employees (AWA). However, Oslo only has three Nobel awards, and the last came in 1989 (the other two in 1969). This means that most of the variance between University of Oslo and Scandinavian universities ranked below is due to these three awards. In our full paper we will conduct similar analysis for all four major Norwegian universities in both THE and ARWU.

*Figure 1: Exemplifying the decomposition: University of Oslo in ARWU.*

Discussion
The analysis show that differences in rank positions may be attributed to both small variations on what we believe are not important indicators, as well as substantial variations on what we believe are important indicators.
We believe that while the rankings show good consistency regarding which universities make it to the top-10 or top-20, the level of consistency drops immensely the farther down the rankings one looks. Reasons for why a university may be ranked 70th in one ranking and 175th in another appear random and without much substance. Further, we urge not to give the rank positions (and potential climbs up or down) much emphasis, as the relative differences between universities found outside the top-100 are extremely small.

In a Scandinavian context, the Norwegian universities are weakly ranked in ARWU and THE primarily due to lower citation indexes and weaker scores in THE’s reputation survey. Only the former finding conform with data available elsewhere: 1) Norwegian universities are generally lower cited than other Scandinavian universities, 2) Norwegian universities produce fewer researchers with the ability to publish in Nature and Science, or to accumulate enough citations to be included in Thomson Reuters’ lists of the world’s most cited researchers. With these two – and to various degree – important conclusions, we see that the rankings may tell us something about indicators related to scientific excellence, i.e. research. They do not, however, tell us much about differences related to teaching quality at the universities. In general, differences in rankings do not give any valuable strategic information before the ranks are decomposed into the actual indicators that they are constructed from.
What is an emerging technology?8
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Session on Technology transfer and cooperation between academia and industry
Wednesday 2nd of September, 11:00 – 12:30, room 355.

Introduction

Emerging technologies are perceived as new technologies with the potential to change the economy and society. For this reason, these technologies have been the subject of much debate in academic research and also a central topic in policy discussions. Evidence of the increasing attention being paid to the phenomenon of emerging technologies can be found in the growing number of publications dealing with the topic and news articles mentioning emerging technologies (in their headlines or lead paragraphs), as depicted in Figure 1.

8 We acknowledge the support of the People Programme (Marie Curie Actions) of the European Union’s Seventh Framework Programme (FP7/2007-2013) (award PIOF-GA-2012-331107 - NET-GENESIS: Network Micro-Dynamics in Emerging Technologies). The extended version of this paper is published as Rotolo, D., Hicks, D., Martin, B. (in press). What is an emerging technology? Research Policy].
Nonetheless, no consensus has emerged as to what qualifies a technology to be emergent. Definitions proposed by a number of studies overlap, but also point to different characteristics. For example, certain definitions emphasise the potential impact emerging technologies are capable of exerting on society (e.g. Porter et al., 2002), while others give great importance to the uncertainty associated with emerging technologies (e.g. Boon & Moors, 2008) or to the characteristics of novelty and growth (e.g. Small et al., 2014). This also extends to the variety of methodological approaches that have been developed, especially by the scientometric community, for the detection and analysis of technological emergence (e.g. Glänzel & Thijs, 2009).

9 Publications were retrieved by querying SCOPUS data with the following search string: “TITLE(“emerg* technol*”) OR TITLE(“emergence of* technolog*”) OR TITLE(“techn* emergence”) OR TITLE(“emerg* scien* technol*”)”. News articles were identified by searching for “emerg* near2 technolog*” in article headlines and lead paragraphs as reported in FACTIVA.
2012). These methods build on relatively loose definitions of emerging technologies or often no definition at all is provided.

The present paper aims to address these shortcomings. To do so, we attempt first to integrate different conceptual contributions on the topic in a precise definition of ‘emerging technology’. Then, we develop a framework for the operationalisation of emerging technologies on the basis of scientometric methods.

**Defining and operationalising emerging technologies**

A core set of twelve studies that provided definitions of emerging technologies was identified by reviewing innovation studies literature (see Figure 1). The proposed definitions pointed to a number of features of emerging technologies that we summarised in terms of attributes: (i) radical novelty, (ii) relatively fast growth, (iii) coherence, (iv) prominent impact, and (v) uncertainty and ambiguity. Building on these attributes, we define an emerging technology as a radically novel and relatively fast growing technology characterised by a certain degree of coherence persisting over time and with the potential to exert a considerable impact on the socio-economic domain(s) which is observed in terms of the composition of actors, institutions and patterns of interactions among those, along with the associated knowledge production processes. Its most prominent impact, however, lies in the future and so in the emergence phase is still somewhat uncertain and ambiguous.

The review of scientometric methods for the operationalization of the attributes of emergence revealed that scientometric analysis is particularly appropriate for the operationalisation of growth, novelty and coherence. Relatively fast growth is often evaluated by counting documents over time. Radical novelty is identified with the appearance of new clusters of documents or words in citation or co-word analyses. Indicators based on entropy measures or on the appearance of new categories (e.g. journals, technological classes) were instead identified as more suitable for assessing coherence.
Conclusions

The contribution of scientometrics to the detection and analysis of emerging technologies is strongly dependent on time (techniques are intrinsically more effective for retrospective analyses than contemporary examinations), on the nature of the attribute (e.g. uncertainty and ambiguity are not easy to evaluate given the current state of the art in scientometrics), and on used data (most studies have focused on publication and patent data). The risk that the detected technological emergence is an artefact of the used models and choices adds to these major limitations. To reduce the likelihood of detecting false positives or missing patterns, a coherent conceptualisation of what is an emerging technology is firstly required. In this regard, our paper provides an important contribution.

References


To beat non-peer bureaucrats: the gains of being metric-wise

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Session on Evaluation and its outcomes
Wednesday 2nd of September, 11:00 – 12:30, auditorium.

Metric-wiseness
Observed differences in bibliometric knowledge among colleagues inspired us to define the concept of ‘metric-wiseness’ for researchers as: “a researcher’s capacity to use the characteristics and formats of scientometric indicators to present one’s true research value” (Rousseau & Rousseau, 2015). This definition is based on the related concept of ‘test-wiseness’. As stated by Millman et al. (1965, p.707), “test-wiseness is defined as a subject's capacity to utilize the characteristics and formats of the test and/or the test taking situation to receive a high score. Test-wiseness is logically independent of the examinee's knowledge of the subject matter for which items are supposedly measures.”

Metric-wiseness is also logically independent of researchers’ scientific capacities regarding their subject matter for which the indicators supposedly measures. Being or not being metric-wise does not depend on the quality of researchers in their field.

Being metric-wise could lead to an advantage for knowledgeable researchers over uninformed colleagues, even when they are of otherwise equal competence. This would lead to a situation where some teams advance faster than other ones. Combined with a Matthew effect (Merton, 1968), this situation would then continue to exist over time.

Influence of metric-wiseness on the research process
The decision of doing research and what type of research to pursue is determined by intrinsic motivational factors such as intellectual curiosity or
a desire to create benefits to society and extrinsic factors such as a desire to increase one’s standing, to avoid failure or to obtain funding (Deci et al., 2001; Lach & Schankerman, 2008). We now develop a conceptual model to describe how metric-wiseness can influence the research process as well as researchers’ communication strategies. We identify two paths through which metric-wiseness can play a role and lead to behavioural changes in the research process.

As a first path, metric-wiseness can be seen as an additional tool that is useful in reporting one’s research portfolio. For example, it may be interesting to include journal indicators and citation counts from Scopus besides those from the Web of Science (WoS). Moreover, it is useful to know that Google Scholar records citation counts and indices for non-English publications and even working papers. This aspect is of particular importance for many colleagues performing research in the Social Sciences and in the Arts and Humanities.

A second, less desirable path through which metric-wiseness can change the research process is by crowding out intrinsic motivational factors for doing research. Thus research topics and publication avenues are no longer selected out of a desire to increase the pool of knowledge or to advance science, but to maximize a researcher’s bibliometric indicator levels. From this point of view only publications in journals with a high impact factor are worthwhile, while writing in other languages besides English is pointless.

**Measuring metric-wiseness**

Next, we develop a framework for measuring the degree of metric-wiseness of researchers. We start by identifying three possible ways in which metric-wiseness can be expressed: 1) using indicators, 2) misusing indicators, and 3) moving beyond indicators. Based on these insights, we propose a two-levelled approach to measure metric-wiseness. On a first level one just asks if the respondent is familiar with the concept of one or more popular indicators such as a journal impact factor. On a second level, we aim to identify the manner through which this metric-wiseness is expressed. To this end, we propose to use a multidimensional Likert-scale with several statements trying to measure three dimensions regarding indicators: technical knowledge, external pressure, and intrinsic motivation.
To illustrate the concept, we investigate the presence and impact of metric-wiseness in a sample of 140 agricultural economists. From this sample, we find that metric-wise respondents seem to be more motivated by a desire to contribute to scientific progress in their discipline and to improve their standing in their current institution. Moreover, we find that metric-wise respondents are significantly less likely to distribute their research findings to policy makers and practitioners in their field.

Overall, the empirical results confirm that extrinsic motivators become more important for metric-wise researchers and may even point to a crowding out effect of intrinsic motivations in researchers’ decision making processes.

Conclusions
Due to the double sided nature of metric-wiseness, it is not a priori clear how institutions or evaluators should react. As long as metric-wiseness is seen as a tool to improve communication about a researcher’s portfolio, it is beneficial to stimulate knowledge of bibliometric indicators among researchers. For instance, it may be interesting to inform doctoral researchers on the what and how of the most frequently used indicators.

When metric-wiseness leads to a crowding out effect, it should clearly be counteracted. A possible solution is to use not only quantitative measures for the assessment of researchers, but also qualitative measures, including peers in the process. As scientometric indicators, even synthetic ones, are never completely correct and at best probably approximately correct (PAC) (Rousseau, 2015) one always needs peers to include qualitative aspects in a research evaluation exercise. A purely bureaucratic and quantitative approach can never be beneficial for individual scientists and science in general.

References


Rousseau, R. (2015). Citation data as a proxy for quality or scientific influence are at best PAC (Probably Approximately Correct). *Journal of the Association for Information Science and Technology* (to appear), DOI: 10.1002/asi.23525

Uncertainty in postdoc citation performance re-examined with Bayesian data analysis

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Session on Advanced topics in research data
Friday 4th of September, 10:30 – 12:15, room 355.

Introduction
When uncertainty is supposed to be addressed, quantitative analyses in research policy and scientometrics, as well as quantitative research assessments, are characterized by an almost exclusive use of “null hypothesis significance tests” (NHST), and this despite the fact that NHST is highly problematic and more informative alternatives such as Bayesian data analysis exist (e.g., Wagenmakers, 2007). It is important for our community to grasp that NHST is flawed and have severe limitations for the data and settings we examine and that there are more suitable alternatives which should also be embraced. The present paper briefly demonstrates the usefulness of Bayesian data analysis in a simple example where the performance of a Danish postdoc funding program is compared to a carefully matched control group, and the results of NHST and Bayesian approaches are contrasted.

We argue that, contrary to NHST, Bayesian interpretations are intuitive and most often produce the knowledge we actually seek. Bayesian data analysis is radically different from NHST. It is based on probability calculus. Before considering any newly collected data, the analyst must specify the current uncertainty for the parameter values in an acceptable manner for a sceptic audience. Probability calculus joins our prior uncertainty in the parameters with the data to produce a complete posterior distribution which indicates the relative credibility of the parameter values. Consequently, in contrast to NHST, Bayesian analyses estimate the probability of the parameter values given the data, \( p(\theta|D) \), whereas frequentist tests estimate the long-run frequency of observing similar or more extreme data given the null hypothesis parameter, \( p(D+|\theta_{Ho}) \). Bayesian inference considers the data
to be fixed, and parameters to be random because they are unknowns. Frequentist inference considers the unknown parameters to be fixed, and the data to be random. “The Bayesian approach delivers the answer to the right question in the sense that Bayesian inference provides answers conditional on the observed data and not based on the distribution of estimators or test statistics over imaginary samples not observed” (Rossi, Allenby & McCulloch, 2005, p. 4).

**Data and methods**

Our data constitutes a comparison between an individual postdoc program funded by the Danish Research Council, and a carefully matched control group of researchers at approximately the same career level. Previous analyses of these data have been presented in Schneider and van Leeuwen (2014). Our previous study showed that both groups performed well above the average citation impact level and that there was a small but unstable difference in impact between the postdoc group and the control group. However, the previous study also exemplifies the many challenges of characterizing uncertainty of such a non-experimental data set. A notably feature of this and many similar data sets, is that they fit very poorly with the assumptions required for traditional frequentist statistics. Hence, we find it important to show that there are alternatives which are more suitable and more informative for data analyses in our field; this is the purpose of the present study.

The goal in Bayesian data analysis is to estimate parameter values because they carry meaning, and not simple “significance” decisions which are arbitrary and ill informed. Parameters describe the tendencies in the data. In this analysis, we apply mildly informed prior probabilities. This means that our prior probabilities have limited influence on the posterior probabilities. Based on previous experience with citation performance of aggregated units, we use the $t$ distribution as a plausible description of the performance data with its combination of a normal distribution around the centre and a long right-tail. In the case of comparing the two groups, we thus have five parameters: the means ($\mu_1$ postdoc and $\mu_2$ control), the standard deviations ($\sigma_1$ postdoc and $\sigma_2$ control) and the parameter for normality (i.e., modelling the tails with a shifted exponential) ($\nu$). The standard deviations are described by broad uniform distributions. Based on the a priori defined priors of the parameters and the observed performance data for the two
postdoc groups, we subsequently compute the posterior distributions using numerical integrations; we apply Markov chain Monte Carlo (MCMC).

**Results and discussion**

We examine the data from both from a traditional NHST perspective and from a Bayesian perspective. We demonstrate that the NHST approach leaves us with several possibilities both parametric and non-parametric, and a few of them provides publishable $p$ values, but we need to understand that we still only have $p(D+|H_0)$, that the $p$ values and CIs rely on unobservable data, sampling intentions and must be interpreted from a future perspective of infinite random samples, and finally, this taken together gives us very little information of the uncertainty in our actual data or parameters. Our Bayesian estimation on the other hand provides us with robust estimates of parameter values with proper probability distributions readily available for intuitive interpretations. The mild informed priors perform well and most importantly, assumptions are open for inspection. Given the proposed priors and the actual data, the estimated posterior parameters inform us that an average performance difference of 0.22 MNCS points in favor of the postdoc group is most probable with a mass density of the 95\% credible interval spread symmetrically around the mean from 0.06 to 0.38. This corresponds to $p(\theta|D)$, the information researchers want. Such information is not available with NHST, here we get the much less informative $p(D+|\theta_{H_0})$.

We should not pay too much attention to the fact that the two approaches in the present case probably would lead to different decisions. It is much more important to acknowledge the far richer information coming out of the Bayesian approach and the clearly much more intuitive interpretation of this information. Bayesian analysis has a lot of potential. Contrary to NHST, Bayesian analyses have no problems with “accepting” null hypotheses, small sample sizes, multiple comparisons, hierarchical and complex modelling. Bayesian analysis can implement cumulative scientific progress by incorporating previous knowledge into the specification of the prior uncertainty, as deemed appropriate by peer review. This is not a question of which approach is most correct. In real research we never know the ground truth; all we have is a sample of data. Therefore, instead of asking which method is more often correct in some hypothetical world of simulated data, the relevant question is asking which method provides the richest, most
informative, and meaningful results for any set of data. We claim that Bayesian estimation always does.

References


A Sciento-Text Framework for Thematic Area-based Ranking of World Institutions in Computer Science Research\(^{10}\)

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Session on Performance measurement in higher education and rankings Thursday 3rd of September, 16:00 – 18:00, auditorium.

Introduction

This paper presents a Sciento-Text framework for ranking leading world institutions (top 100) in Computer Science (CS) and in different thematic areas of CS. This analysis uses data corresponding to CS research output indexed in Web of Science (WoS) for the period 1999-2013. The ranking framework first produces a quantity-quality composite rank for the CS domain as a whole and thereafter ranks on different thematic areas of research. Identifying research competitiveness of institutions is quite challenging but useful exercise. The research policy makers, funding agencies, prospective students, prospective employers and the academic community, all get benefitted from it. Over the years various ranking systems for institutions have been developed. However, they are limited to computing some numerical ranks for various institutions. None of them try to identify research strengths of institutions’ performance at a fine grained level. We first identify the leading institutions in CS research domain through a quantity-quality composite ranking system and then a text-based analysis is performed to identify thematic research strengths of the leading institutions.

\(^{10}\) This work was supported by research grants from Department of Science and Technology, Government of India (Grant: INT/MEXICO/P-13/2012) and University Grants Commission of India (Grant: F. No. 41-624/2012(SR)).
Overall Rank of Leading Institutions
A standard scientometric methodology is adopted along with a text-based computational analysis for this ranking framework. First, an overall rank is generated for leading institutions in the dataset based on four main scientometric indicators, namely Total Publication (TP), Total Citation (TC), HiCP (Highly Cited Papers), Internationally Collaborated Paper (ICP). The notion of quantity-quality composite rank tries to identify top institutions not only on their total output but also by incorporating the impact of that output. We use TP to refer to ‘quantity’, as it is solely a quantitative parameter of counts of total published papers by an institution. It is well established (Hu et al., 2014; Lee & Bozeman, 2005) that an ICP gets more attention than a locally collaborated papers or non-collaborated paper. Hence, like TC and HiCP, ICP also can be used as indirect measure of quality.

Thematic Area-wise Ranking
The main motivation for this study is to identify the major research themes pursued and advanced by the institutions. The entire data was processed to classify each publication in some of the 24 major thematic areas in CS. This thematic mapping is more informative than the subcategory labels used by the WoS index and is extended from a recent previous work (Singh et al., 2015). To classify a paper in a thematic area, its ‘author keyword’, ‘paper title’ and ‘abstract’ fields are analyzed. After attributing thematic areas to each paper, we computed thematic-area based ranks by measuring the thematic area-wise indicators of all the institutions.
Table 1. Rank (thematic area-wise and overall) for top 5 institutions.


<table>
<thead>
<tr>
<th>Institution</th>
<th>R15</th>
<th>AT</th>
<th>SP</th>
<th>HA</th>
<th>SE</th>
<th>AI</th>
<th>ML</th>
<th>DM</th>
<th>IR</th>
<th>NL</th>
<th>GR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Massachusetts Institute of Technology</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td>4</td>
<td>14</td>
<td>7</td>
<td>4</td>
<td>46</td>
<td>29</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>University of California Berkeley</td>
<td>2</td>
<td>6</td>
<td>16</td>
<td>2</td>
<td>13</td>
<td>41</td>
<td>3</td>
<td>3</td>
<td>30</td>
<td>1</td>
<td>22</td>
</tr>
<tr>
<td>University of London</td>
<td>3</td>
<td>9</td>
<td>4</td>
<td>53</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>Stanford University</td>
<td>4</td>
<td>12</td>
<td>1</td>
<td>1</td>
<td>46</td>
<td>17</td>
<td>21</td>
<td>12</td>
<td>17</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Nanyang Technological University</td>
<td>5</td>
<td>48</td>
<td>22</td>
<td>12</td>
<td>16</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td>10</td>
<td>6</td>
<td>18</td>
</tr>
</tbody>
</table>

Results and Discussion

We computed composite ranks for each of the 24 thematic areas and ranked the 100 institutions on their overall research performance. The table 1 shows the composite ranks for 5 institutions in 10 thematic areas. As we can clearly see, the thematic area ranks for the 5 institutions are different. Also, despite the fact that these institutions have top-most composite ranks, they do not stand on top in all thematic areas. Also for few thematic areas, the top ranking institutions are out of this top-5 set. The figure 1 plots the strength of all the 24 thematic areas for the 15 year period. It was also observed that some thematic areas such as ‘artificial intelligence’ and ‘computer software and applications’ have attracted more researchers and resulted more publications.
Figure 1: Thematic research strength for top 5 institutions.

References


How to solve computational challenges in large scale hybrid document networks?
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Session on Bibliometrics and citation analysis
Thursday 3rd of September, 16:00 – 18:00, room 355.

Introduction
The analysis of hybrid documents networks have proven to be a valuable tool in science mapping studies. In these hybrid networks, documents are connected through weighted links based on an aggregation of citation based links and lexical similarities. The application of the current methodology suffers significantly from the high computational requirements that it poses. The number of possible links grows quadratic with the number of nodes in the document set. Increasing a reasonably sized network with a set of documents can have large implications on the required resources of the used computer hardware. Recently we implemented a novel method for the extraction of noun phrases based on Natural Language Processing which limited the set of terms used for the calculation of the lexical similarity considerably. This resulted in a decrease of the density of the lexical network without affecting the structure of the network. In this paper we investigate several other strategies that can be applied to reduce the size and density of the network.

The first strategy limits the number of documents in the network by using different time windows. A dataset on Astronomy & Astrophysics comprising 110,412 publications was downloaded from Thomson Reuters Web of Science covering the annual volumes 2003–2010 and shared with all contributors of the project on ‘Measuring the Diversity of Research’. In this data set we define eight different times ranges from 1 up to 8 years all ending with the 2010 volume.
This approach allows us to study the effect of different time windows on the 2010 volume. Other strategies aim at reducing the number of links among documents, thus the density of the network. Such strategies will allow us to analyse large networks covering larger time periods or broad subject fields while we aim at reducing the computational requirements without compromising on the quality or structure of the network and the cluster analysis.

**Methods and Results**

Proceeding from our original approach with the combination of bibliographic coupling (BC) and single-term based textual similarities we apply two adaptations. For the link based component we use (undirected) direct citation links (DC) with two different thresholds instead of the previously used BC. For the lexical based component we apply similarities on the basis of document-noun phrases with two different thresholds instead of single terms. In particular, we have implemented a procedure based on Natural Language Processing using the Stanford Parser to extract noun phrases from titles and abstracts. For bibliographic coupling and the lexical approach we set two different thresholds for the similarities: 0.01 and 0.05.

For each of the constructed networks we apply the Louvain Community Detection. As we are only interested in comparing the different strategies, the resolution parameter remains constant across all analyses and is set to the value 1.0. Consistency across different time frames within one strategies and among strategies within a given time frame are measured using the Cramer’s V statistic. This is a measure for the association between two nominal variables and ranges between 0 and 1 where 1 expresses complete match of the two variables.

The first results refer to the link-based approach. The DC approach results in many different clusters with a high modularity score but the size of the selected time frame has a substantial effect on the results of this community detection procedure. By extending the time frame the number of clusters diminishes and the modularity score decreases. Share of documents with at least one link to any other document decreases with shrinking time windows. These observations substantiate that the direct citation approach is very sensitive to the selected time window, while BC shows more stable patterns with higher consistency. The influence of the thresholds is limited.
Almost all documents in the lexical similarity based network have at least one link to another document in the set. The density slightly decreases with an extending time frame but the application of the threshold has a larger impact than with the bibliographic coupling. The comparison of the clustering results over the time frames reveals that these have only a small effect on the number of clusters and the modularity scores. However, the Cramer’s V test shows that the extension of the time frame has an effect similar as on BC on the assignment of the documents to the clusters. Another approach is to limit the number of edges between the documents as this reduces the size of the network file and speeds up the cluster procedure. The first threshold (0.01) did not have any effect on the link based network while it proved to be useful for the lexical. The higher threshold (0.05), however, distorts the network too much and should therefore be discarded.

*Table 1. Comparison of three hybrid alternatives of the 2007-2010 networks*

<table>
<thead>
<tr>
<th>Hybrid</th>
<th>Density</th>
<th>Cluster</th>
<th>Modularity</th>
<th>Cramer’s V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hybrid</td>
<td>9.07%</td>
<td>10</td>
<td>0.44</td>
<td>1.00</td>
</tr>
<tr>
<td>Hybrid (s ≥ 0.01)</td>
<td>4.24%</td>
<td>10</td>
<td>0.49</td>
<td>0.93</td>
</tr>
<tr>
<td>Hybrid (50% Sample)</td>
<td>3.93%</td>
<td>9</td>
<td>0.50</td>
<td>0.86</td>
</tr>
</tbody>
</table>

Table 1 gives the results of the hybrid approach where the weight of the link component in the linear combination of the angles underlying the similarity is set to 0.5 so that each component contributes equally to the calculated similarity. As there was only a marginal effect of the 0.01 threshold in bibliographic coupling we use the original network. For the lexical component we used the original network, applied the 0.01 threshold and the network based on the 50% sample. The results are all very similar in the three versions.

**Conclusions**

The results of this study show promising strategies for dealing with the computational challenges that surface with the large document networks. We tried to reduce the size of the document set by restricting the time frame but observed an effect on the structure of the citation based networks. The network based on direct citations is highly sensitive to the selected time
frame and fails as an alternative to bibliographic coupling. The latter one is also sensitive to the used time frame. It seems that this sensitivity is capable of capturing structural dynamics in the selected document set.

In the lexical approach we used another strategy where samples were taken from the document-noun phrase pairs prior to the calculation of the similarities. This proved to be very efficient for reducing the time required for network creation and the results after clustering were much in line with the original approach. A slight deviation was observed in the number of clusters in the hybrid approach. In future research we will apply more intelligent sampling methods so that most strong links in the network are retained.
Predictive validity of career grant selection

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**Royal Institute of Technology, INDEK, Stockholm & Örebro University, Business School, Örebro (Sweden), ulf.sandstrom@oru.se.

Session on Academic careers
Thursday 3rd of September, 10:45 – 12:30, auditorium.

The competition for career grants is increasingly sharp. The main rationale behind competing for career grants is that this will help selecting top talent that will develop into the next generation leading scientists. In this paper we investigate whether selected applicants are indeed performing at the expected excellent level – something that is hardly investigated in the literature.

Does career grant competition result in the selection of the best young talents? In this paper, the predictive validity of grant decision-making is investigated, using a sample of 250 early career grant applications in three social science fields. We measure output and impact of the applicants about ten years after the application to find out whether the selected researchers perform ex post better than the non-successful ones (Table 1). Field normalized size-independent and size-dependent indicators are used.

Table 1. Post performance

* sign. < 0.01; ** sign. < 0.05; *** sign. < 0.10; # size-dependent indicators

# For more details, see [1, 2]. The relation between past performance and grant selection for this case, see [3].
<table>
<thead>
<tr>
<th>Success</th>
<th>Papers (integer)</th>
<th>49 successful versus all 184 non-successful applicants*</th>
<th>49 successful versus 49 best performing non-successful**</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes</td>
<td>26.4*</td>
<td>20*</td>
<td>26.4</td>
</tr>
<tr>
<td>no</td>
<td>11.9</td>
<td>8</td>
<td>105.17</td>
</tr>
<tr>
<td></td>
<td>7.7*</td>
<td>7.3*</td>
<td>161.62**</td>
</tr>
<tr>
<td>yes</td>
<td>4.0</td>
<td>3.5</td>
<td>105.12</td>
</tr>
<tr>
<td>no</td>
<td>1.4**</td>
<td>1.1*</td>
<td>136.16**</td>
</tr>
<tr>
<td></td>
<td>1.1</td>
<td>0.96</td>
<td>111.90</td>
</tr>
<tr>
<td></td>
<td>1.4</td>
<td>1.2</td>
<td>134.31**</td>
</tr>
<tr>
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<td>4.9</td>
<td>3.1</td>
<td>105.69</td>
</tr>
<tr>
<td>no</td>
<td>12.5*</td>
<td>8.9*</td>
<td>159.47**</td>
</tr>
<tr>
<td></td>
<td>1.2</td>
<td>1.1</td>
<td>112.39</td>
</tr>
<tr>
<td></td>
<td>0.02</td>
<td>0</td>
<td>128.62***</td>
</tr>
<tr>
<td>yes</td>
<td>0.01</td>
<td>0</td>
<td>113.90</td>
</tr>
<tr>
<td>no</td>
<td>0.08</td>
<td>0.04*</td>
<td>134.03**</td>
</tr>
<tr>
<td></td>
<td>0.06</td>
<td>0</td>
<td>112.46</td>
</tr>
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<td></td>
<td>0.17</td>
<td>0.13**</td>
<td>137.63**</td>
</tr>
<tr>
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<td>0.13</td>
<td>0.06</td>
<td>111.51</td>
</tr>
<tr>
<td>no</td>
<td>4.7*</td>
<td>3.0*</td>
<td>156.33*</td>
</tr>
<tr>
<td></td>
<td>1.7</td>
<td>1.0</td>
<td>106.53</td>
</tr>
<tr>
<td></td>
<td>0.38***</td>
<td>0.38***</td>
<td>132.27***</td>
</tr>
<tr>
<td>yes</td>
<td>0.32</td>
<td>0.28</td>
<td>112.28</td>
</tr>
<tr>
<td>no</td>
<td>0.67*</td>
<td>0.68</td>
<td>135.28**</td>
</tr>
<tr>
<td></td>
<td>0.58</td>
<td>0.59</td>
<td>112.13</td>
</tr>
</tbody>
</table>
The analysis shows that predictive validity is low to moderate when comparing grantees with all non-successful applicants. Only in terms of output, grantees score slightly higher, but that may indeed be the effect of more resources (the grant) and not of higher quality. Comparing the granted researchers with the set of best performing non-successful applicants, the grantees have on average less impact after about a ten years period. These results suggest that the panel decisions indeed have no predictive validity as far as scholarly performance is concerned. We also tested whether the peer review alone would have been a better predictor, but that is not the case. The review scores hardly correlate with the various post performance variables [1]. Despite the fact that panel members are convinced that real talents are easily recognized [4], our current results suggest the opposite. The common belief that peers and panels are good in recognizing the outstanding talents seems incorrect.

Figure 1: Career by grant-success (percentages)

Secondly, we test whether the career grants do support the career of the grantees, as intended. The results (Figure 1) indicate that receiving a
prestigious early career grant indeed seems to have a strong influence on careers, as grantees have a two to three times bigger chance to become full professor, and remain less often in one of the lower academic ranks. On average, the granted applicants reached a full rank higher than the others within the ten years period under study. In this sense, the funding instrument works as intended. Using a multivariate model, we show that apart from obtaining grants, the achieved career level is influenced by gender, and also by publication output and citation impact [1]. Overall, this suggests that non-academic factors such as the symbolic value of grants, and the gender of the candidate do impact academic careers in the early phase.

References


Application-oriented university research in the new millennium: bibliometric study of general trends within universities worldwide

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Session on Characterizing higher education institutions
Friday 4th of September, 10:30 – 12:15, auditorium.

Research question and methodology
Each research-active university has a unique institutional profile in so far as the kind of research that is done. The multidimensional nature of the research activities runs across several distinctive spectra such as: “basic” to “application oriented” research, theoretical to empirical, observational to experimental, incremental to breakthrough. Previous work suggests a global trend toward more ‘application oriented’ research in world science (Tijssen, 2010). This study further investigates these changes on the basic-applied spectrum, now also at level of world’s 750 largest research-intensive universities. Even though most research-intensive universities are stable organizational entities, with little change in from year to year, we expect to see some noteworthy changes among these universities since the year 2000, an era in which several universities have undergone major restructuring or mergers, and some countries such as China have invested heavily in expanding and upgrading their university research systems. Has ‘application oriented’ research become more prominent in recent years? And which universities are driving this trend?

Our analytical approach fits within a stream of large-scale empirical studies that examine relationships and interactions between university research and associated knowledge application domains (Narin et al., 1976; McMillan et al., 2000; Boyack et al., 2014). Building on the work by Tijssen (2010), who analyzed macro-level trends in world science during the years 1999-135
2008 as represented in CWTS’s in-house version of Thomson Reuters’ *Web of Science* database (WoS), we conduct an updated trend analysis across the entire WoS and subsequently zoom in on institutional dynamics of the world’s 750 largest research-intensive universities. The analysis covers the time-period 2000-2013.

Our breakdown of the research literature is based on ‘Research Focus’ classes, identical to the six categories of the ‘Journal Application Domains’ classification system that was introduced by Tijssen (2010):

- Discovery science – journals with a large share of papers produced by university researchers (including academic hospitals); very few or no contributions from industry and private sector organizations, or from hospitals and medical centers outside the university system;
- Industrial relevant science - industry relevant journals with a substantial share of papers
- (co-)produced by industry R&D staff;
- Science-based technological development - industry practice journals, with a large relatively share of contributions from industry R&D staff;
- Clinically relevant science - clinical relevant journals with a substantial share of papers
- (co-)produced by staff at hospitals and clinics outside the university system;
- Science-based clinical practice – clinical medicine journals with many contributions from staff at general hospitals and clinics;
- Industrial-medical development – journals at the intersection with contributions from industry and general hospitals (notably related to biotechnology and pharmaceutics).

**First results**

We find that some universities that have gone through remarkable changes in recent years in shifts towards application-oriented science. Our preliminary results also raise several new questions and further research into relevant organizational determinants and explanatory factors. One factor we need to investigate is the effect of international research cooperation and/or research cooperation with the business enterprises (Tijssen, 2012). Another factor is the possible impact of funding criteria on national university research systems. Managerial practices and (government-imposed)
performance indicators are becoming major driving forces for research behavior in an increasingly large number of countries worldwide (Hicks, 2012) where expectations as to practical utilization and commercialization of research findings have become key funding criteria that may significantly affect the choice of research topics within universities.

References


Incorrect research and its impact seen through the bibliometrics looking glass: The effect of the misidentified cell line KB (HeLa) on scientific literature

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Session on Bibliometrics and citation analysis
Thursday 3rd of September, 16:00 – 18:00, room 355.

Introduction
Citation analysis of research papers using contaminated reagents or invalid assumptions can measure the consequences of invalid or irreproducible results in the scientific literature. As an illustration of the problem, we have examined how one cell line has contributed to this problem. Human cell lines have been widely used as in vitro models to study various aspects of cellular biology and human diseases. In 1968, HeLa cells, originally derived from an adenocarcinoma of the uterine cervix in 1951, were shown to have been the source of many false cell lines and yet these imposter cell lines continue to be used as models under their false identities. This bibliometric analysis explores the consequences to the scientific literature from using the KB cell line, a known HeLa derivative that was originally...

11 The authors would like to thank Bart Thijs (ECOOM, KU Leuven) for his assistance in data retrieval.
purported to be from an epidermoid (i.e., squamous) carcinoma of laryngeal tissue and that continues to be used as a model of oral cancer cells.

Methods
To gather papers that used KB cell lines, two separate searches for the term “KB” were conducted using the PubMed database. The first search aimed to detect “correct” usage of the KB cell line, which was defined as a publication using KB with an accurate description. Accurate descriptions included “cervical”, “cervix”, and “adenocarcinoma”. The second search aimed to detect “incorrect” usage of the KB cell line, defined as a publication using KB with an inaccurate or misleading description. Inaccurate descriptions included “head and neck”, “oral”, “epidermoid”, “squamous”, or “SCC” (the customary abbreviation for squamous cell carcinoma). A manual review, looking at titles and abstracts, was performed to confirm correct and incorrect usage and to exclude papers with unclear descriptions. Papers published before the year 2000 were excluded, mainly because new technologies became available at around that time to make testing more widely accessible.

A total of 57 papers were identified for the “correct” dataset, and 574 for the “incorrect” dataset. As papers published in recent years may not have sufficient time to attract citations, we excluded papers published from 2011 on. This leaves 29 “correct” papers for this pilot study. As citation counts are very sensitive to the publication years, we paired these “correct” papers with 29 “incorrect” papers chosen at random from the same years of publication. Citations to these 29 pairs of papers were retrieved from 2001–2013 annual volumes of Thomson Reuters Web of Science Core collection database (WoS). All citing papers were assigned to countries according to the address of the authors' research organization.

Results
There are ten times more papers using the KB cell line incorrectly compared to those using the cell line correctly (574 and 57, respectively), showing that incorrect usage of the KB cell line is pervasive. This is alarming, given that the true identity of the KB cell line as HeLa was first reported in 1968. On average, correct papers attracted more citations than the incorrect papers did, but the difference is not statistically significant. The two main types of citing papers are regular papers and review papers. The citations to correct
versus incorrect papers for regular and review papers are proportionally the same, i.e., review papers do not cite more incorrect papers than regular papers and vice versa.

The country distribution of citations to correct vs. incorrect papers is uneven. Authors from China and India cited more correct papers while those from Japan and Italy cited more incorrect papers. Authors from USA, Germany, and UK cited around the same number of correct and incorrect papers. Caution should be exercised when interpreting the country pattern reported here. Fields of research could be a confounding factor. If a particular field tended to use misidentified cell lines more frequently and a particular country conducted more research in that field, it could result in authors from that country citing more incorrect papers.

The proportion of correct papers in recent years (2010-2014) has increased, although they are still outnumbered by incorrect papers. This increase of correct papers may be the result of recent efforts to improve awareness of the cell line contamination issue. These efforts include agreement on a consensus method of authentication testing for human cell lines and the establishment of the International Cell Line Authentication Committee (http://iclac.org). However, the proportions of citations to correct and incorrect papers do not show significant signs of change even when considering the most recent years, suggesting that any improvements in citation practice will lag behind changes in publication practice and leave many incorrect papers to plague the research literature.

**Discussion**

A limitation of the study is that we have only studied recent literature using the KB cell line. KB is only one of almost 500 known false cell lines, albeit a major one, so the findings of the study should not be generalized to the literature of other cell lines without further validation. A long term direction of future research is to extend the study to other cell lines. Before extending to other cell lines, however, we see several directions that we can pursue using the KB cell line literature following the current study. First, we will include all papers, not just the 29 pairs of papers in this pilot study, and re-examine questions explored in the current study. Second, we will collect data on Journal Impact Factors (JIF) to find out whether higher impact journals, as measured by JIF, tend to publish fewer incorrect papers (both
original papers and citing papers) and whether there is a significant difference in the JIFs of journals citing correct and incorrect papers. Third, we will compare journals that currently require cell line authentication as part of manuscript submission to those without such a requirement to determine whether journals that require authentication published fewer incorrect papers. We aim to determine whether a requirement for cell line authentication mitigates against usage of false cell lines.
Competition in science: links between publication pressure, grant pressure and the academic job market

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Session on Academic careers
Thursday 3rd of September, 10:45 – 12:30, auditorium.

Introduction
Science is characterized by competition at several levels, e.g., being the first to make a discovery and publish it (Merton, 1957; Hagstrom, 1974), getting recognition from peers (Cole and Cole, 1967), obtaining research funding (Lepori et al. 2007) and securing a faculty position (Stephan, 2012, p. 170; Waaijer, 2015). In this study, we describe how early career researchers perceive publication pressure, or rather the need to publish, which is a result from competition at the publishing level, and grant pressure, a result from competition at the funding level. We also describe the effects these pressures have and their connectedness to competition for jobs. Finally, we study gender difference in the perception and influence of these pressures.

Data Sources and Methodology
We present results from two web surveys conducted within the Netherlands in 2013-2014. One is a survey among 2,193 recent PhD graduates (1,133 responses, for details see Waaijer et al., 2015), the other a survey among 571 postdoctoral researchers (225 responses, Van der Weijden et al., in preparation). In both surveys we included questions on how the respondents perceive the pressure to publish (called publication pressure from this point onwards). In the PhD graduate survey, respondents were also asked about the pressure to obtain grants (grant pressure) in academia. In addition, respondents to this survey were asked to which extent publication and grant pressure made them hesitate to choose a career in academia, and in an open question were asked which long-term career aspects have been most decisive in their choice for their current job. We also asked them to rate
their own scientific work. Finally, we asked them whether they are male or female, and determined their sector of employment, i.e., academic research, non-academic research or non-research. In the postdoc survey, the respondents were asked to rate their satisfaction with twelve items, one of which was publication pressure, and were asked to elaborate on their ratings. We used these quotes to assess the links between publication pressure, grant pressure and other factors, and to provide a more qualitative explanation of the effects these pressures have on early career researchers.

**Results and discussion**

Our results show that an overwhelming majority of recent PhD graduates see the pressure to publish in academia as (far) too high. Even more PhDs perceive the pressure to obtain research grants as (far) too high. On the other hand, when postdocs were asked how satisfied they are with publication pressure, they indicated to be quite satisfied with it. In addition, there is no relation between the perception of publication and grant pressure and actual sector of employment, i.e., publication and grant pressure do not seem to have driven many PhD graduates out of academia. At the same time, our findings do show connections between publication pressure, grant pressure, and career prospects. In particular, PhDs who perceive career prospects in academia as slim are more prone to perceive publication and grant pressure as too high. Responses by PhDs and postdocs to open questions that mention publication or grant pressure often also make notion of (a lack of) career prospects and connect the two. In connection to competition on the academic job market, publication and grant pressure can become a problem for early career researchers. As we show in our paper on career prospects in academia and other sectors, a lack of career prospects does drive some PhD graduates away from academia (C. Waaijer, in preparation).

A previous study on publication pressure (Miller et al., 2011) found that women experience higher publication pressure than men. We do not find such an effect, but find that female PhD graduates more often than men think that grant pressure is too high. In addition, grant pressure has made female PhD graduates hesitant about an academic career more often, despite the fact they are as confident as men about their scientific work. An interesting follow-up question would be why women see grant pressure as
higher than men, and why they report a larger effect of this pressure on their career choices.

In conclusion, we show that competition in academia and its resulting publication and grant pressure are perceived as too high by early career researchers. At the same time, we show that by themselves the effects of publication and grant pressure are limited, if not almost absent. These pressures should not be viewed separately from another competitive process in science, that of the academic labor market. It is by their connection to academic career prospects (or lack thereof) that publication and grant pressure may exert their main influence.

References


Analyzing subject mix of European Higher Education Institutions. An Exploratory analysis using the European Tertiary Education Register data.

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Session on Characterizing higher education institutions
Friday 4th of September, 10:30 – 12:15, auditorium.

Abstract

Specialization by subject domains in higher education institutions is one of the key drivers of heterogeneity and diversity in the sector. Empirical evidence for differences caused by subject specialization is however limited and therefore this paper aims to provide a more extended analysis of the subject mix of higher education institutions in Europe on a significantly large sample by using the newly available European Tertiary Education Register (ETER).

By exploiting the newly available data this paper provides a more extended analysis of the subject mix of higher education institutions in Europe and addresses the following issues: (i) First, we provide descriptive evidence on the extent of specialization of European HEIs by subject field, focusing particularly on the identification of generalist and specialist HEIs and on their importance in terms of number undergraduate students, academic staff and PhD students; (ii) Second, we investigate whether generalist and specialist HEIs are different in terms of some basic characteristics. This will allow a preliminary analysis of the underlying mechanisms driving subject specialization and their interaction with other diversity dimensions in higher education; (iii) Third, we analyze differences between countries concerning the overall patterns of subject specialization, as well as the presence of specialized HEIs in distinct fields.
The results show that there is a large group of generalist universities in European higher education, delivering education in many subject domains at all degree levels. Specialist HEIs are mostly niche players and strongly concentrated in the non-university sector. Also, there is evidence that specific national conditions determine whether education in a subject field is integrated within generalist institutions or delivered by specialized HEIs. The analysis lead to further research questions, especially regarding the differences in specialization patterns between countries, between research and education, and the dynamics of subject mix of higher education institutions over time.

References


How much is scientific and technical information used in science policy: the case of the US National Research Council.\textsuperscript{12}

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Session on Evaluation and its outcomes
Wednesday 2nd of September, 11:00 – 12:30, auditorium.

\textbf{Introduction and Background}

Citation-based indicators have been widely used in policy making to ascertain the quality of science and technology research. This widespread use citation takes place regardless of warnings from bibliometric researchers that citations are not necessarily a valid way to gauge research quality (Glänzel et al., 2006). Despite the central role of citations in evaluating research quality, citations have not been much applied to scientific and technical policy studies.

This paper seeks to attend to this under-explored area by analyzing the use of scientific and technical research papers in policy studies. The paper proposes an indicator based on the extraction and coding of citations of scientific and technical information (STI) in a particular policy report. STI is defined in a somewhat narrower way than is prominent in the literature (McClure, 1988; Walker and Hurt, 1990). It is conceived of as representing open scientific and technical literature appearing in peer-reviewed academic journals. Public values literature (Bozeman 2002, 2007) tells us that there is merit in using the “best” information in crucial public decision-making. Naturally, a consensus does not necessarily exist on the importance of giving STI consideration in public decision making about science policy.

\textsuperscript{12} This work was supported by the National Science Foundation, Award #1262251
STI is the chief information source cited in scholarly articles. In policy reports, on the other hand, STI is used together with a variety of other knowledge sources, including informal and formal communications experts in the field, personal opinion of policy makers (which may draw on expressed political values, self-interest, experiential knowledge, or other sources), other policy reports, and popular media sources newspaper articles and websites. Scientists and engineers would presume to contend that STI should have an important, and maybe, even a favoured position amidst the body of information sources available for public decision-making. To this end, lamentations persist about the need a wider use of STI in policymaking.

This paper centres on use of STI in debatably a significant science and technology policy decision making organization in the United States: the National Research Council (NRC). The NRC conducts research work for the production of reports on science and technology issues within the private non-profit National Academies. The NRC has not been much studied beyond anecdotes and case studies of its social, political and organizational aspects.

Data Sources and Methodology

This paper examines the NRC by creating a dataset from 589 NRC reports published from 2005-2012. This sample is directed toward single-issue empaneled studies because such studies are most apt to draw on STI. We developed a list of NRC reports using the annual reports listed on the National Academies website for each of the years under analysis and downloaded PDFs of these reports. We gathered and coded information available from the PDFs about the study (for example, size of the report, report policy area), about the committee chair and members (for example, affiliation with academia, business, government), and about the references (for example, STI journal articles, total number of references). We particularly focused on two indicators of STI usage: one based on the percentage of all references cited in the report involve STI and a second based on the number of STI references normalized by the total number of pages in the report.

We obtained the STI data through a mixture of (1) automated cleaning and matching methods (using Excel macros) to tag and match report references
to a thesaurus of journal articles and (2) manual review and coding of the references, by two separate coders, to decide whether or not the references were STI. Some NRC reports had a separate list of cited references; these lists presented the references in standardized form and were therefore most easy to clean, match and code as STI. Many, particularly older reports, used a footnote convention. This convention required extracting the footnotes before coding them as STI. In total, the 589 reports had more than 120,000 references.

Results

NRC reports fluctuated in size, from 16 pages to 650 pages with a median of 164 pages and a mean of 188 pages. All but three NRC reports had references and 88% of the reports had references involving STI. The median NRC report had 126 total references and 30 STI references while the mean was 205 total references and 89 STI references, suggesting skewedness with some reports extensively using STI (indeed, one report used 2,330 total cited references of which 1,440 were journal articles). We normalized the measure by reporting the percentage of citations that are STI to address these distributional issues. The median and mean proportion of STI were 0.26 and 0.30 respectively.

We note that the use of STI differs notably by policy area. It is less commonly used in the defence area and more commonly used in the natural resources/environmental area. NRC reports are developed through a committee structure and the use of STI also varies according to the predominance of academics (versus private industry, government or other sector representatives) on NRC committees. These results suggest that STI does play a significant role in the science policy making process of the NRC depending on the policy area and sectoral make up of decision makers.

References


## Poster session

The poster session will take place during lunchtime Wednesday 2nd of September and Thursday 3rd of September.

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